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# THE AMERICAN METEOROLOGICAL JOURNAL.

*A MONTHLY REVIEW OF METEOROLOGY.*

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THE AMERICAN

METEOROLOGICAL JOURNAL.

VOL. IX. BOSTON, MASS., JANUARY, 1893. No. 9.

## DATA (CHIEFLY METEOROLOGICAL) BEARING UPON THE SELECTION OF STATIONS FOR OBSERVING THE TOTAL ECLIPSE OF 1893, APRIL 16.

PROF. DAVID P. TODD.

IN so far as celestial conditions are concerned, total eclipses of the sun occur with perhaps sufficient frequency (about seventy to the century) to satisfy all reasonable requirements of astronomers who desire accurate relative positions of sun and moon, and of solar physicists engaged upon the problems of the sun's constitution and radiation.

But, unfortunately, terrestrial conditions are very often adverse. Many total eclipses, which approach the maximum duration, being visible only within the tropics, are unavailing through the paucity of land localities for observing stations. And very often it happens that meteorological conditions are everywhere so unfavorable, that the opportunities for solar research are largely lost. Notably the eclipses of 1887 and 1889 (II) confirm this statement, while those of 1883 and 1886 were a bare escape.

The necessity, then, of a systematic examination of the cloud conditions of eclipse localities must be apparent. Only thus can the best observing stations be selected, and the opportunities of the eclipse utilized to the utmost.

For the first time, this has been done for the total eclipse of 1893, April 16, with as near approach to comprehensiveness as the limited time since my return from the last eclipse would permit. The aim was to secure, in so far as possible, cloud observations at or near all advantageous observing points, throughout the month of April, 1890, 1891, and 1892, at or

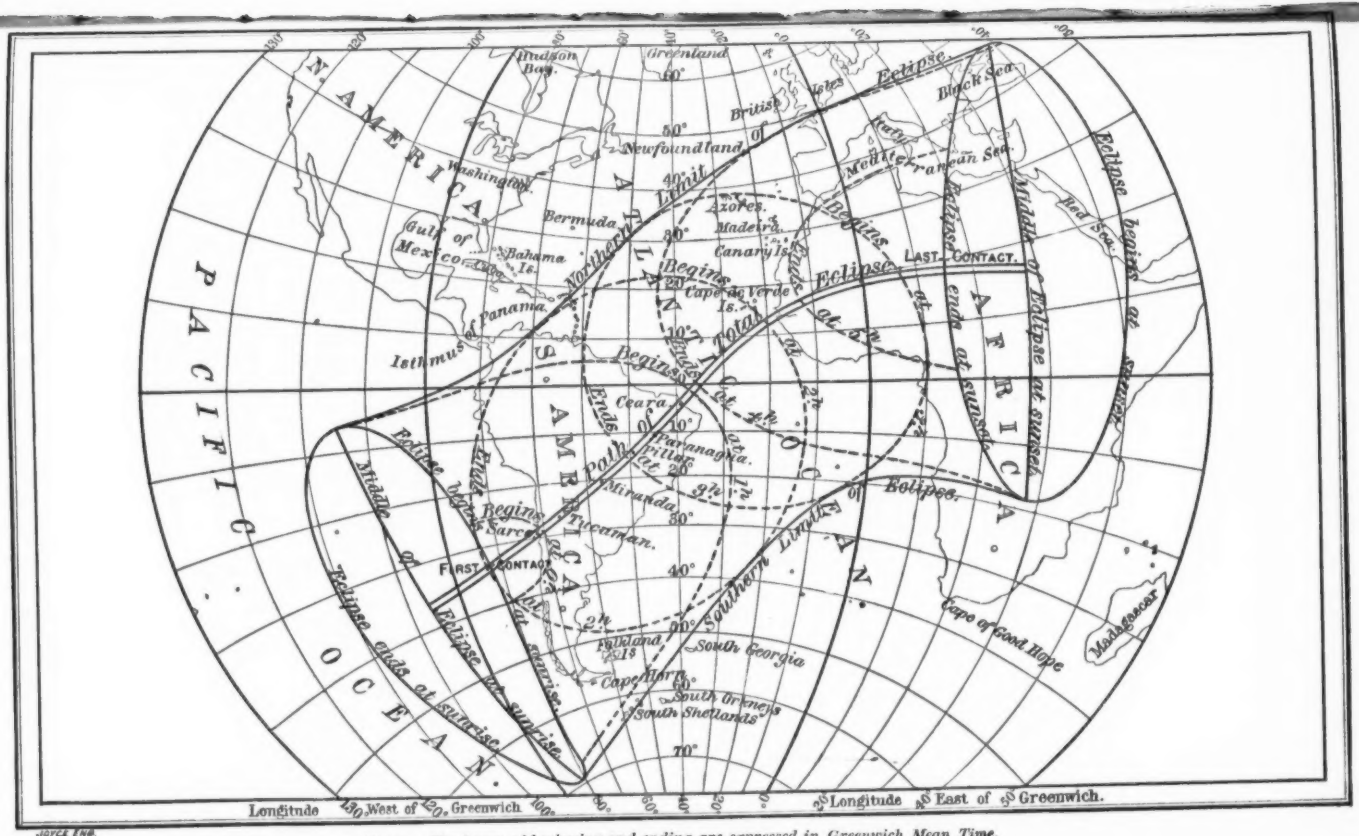
near the particular time of day when the eclipse is to take place at each station. In some regions it has, of course, been impossible to do this : for these the best available data are presented, however meagre.

The accompanying map, for which the JOURNAL is indebted to the courtesy of Professor Simon Newcomb, U. S. Navy, Superintendent of the "American Ephemeris and Nautical Almanac," represents the entire region of visibility of the eclipse. Totality may be observed at all those points of South America, the Atlantic Ocean, and Africa, which are included between the two close and nearly parallel lines. The particular localities available are (in the order of absolute time) Chile, Argentine Republic, Paraguay, Brazil, Senegal, and Sahara. That this eclipse is a rare one in point of totality-duration will appear on reference to "The American Ephemeris and Nautical Almanac," or the "British Nautical Almanac." In Chile, the central-line duration is 2m. 56s., Argentina, 3m. 5s., on the east coast of Brazil, 4m. 40s., and in Senegal, on the west coast of Africa, 4m. 10s.

### CHILE.

An early attempt was made to secure cloud-observations through the Chilean Meteorological Office, but without results. Early in the year 1892, therefore, I addressed a communication to John King, Esq., H. B. M.'s Vice-Consul at Carrizal Bajo, in the hope that astronomers might have the benefit of competent observations throughout, at least, one April, preceding the year of the eclipse. I also made other inquiries of Mr. King, touching the welfare of expeditions which will be likely to select Chile for an observing station. His replies are in every way complete, and the observations of the April sky which he has collected would indicate that the total eclipse is almost certain to be seen in a cloudless sky. The information he gives concerning the mountains of that region, near the central line of the eclipse, also indicates the eminent desirability of occupying them ; as the great elevation in that dry and steady atmosphere will almost surely reveal an intricacy of detail in the coronal structure which observations at sea-level will perhaps never disclose.

As the data collected by Mr. King have for the most part




JOYCE ENG.

NOTE.—*The hours of beginning and ending are expressed in Greenwich Mean Time.*

been already published in advance, for the service of European observers (*Nature*, No. 1198, (13 October, 1892), pp. 561-4), it is only necessary to refer to them here, and to the excellent map of the Desert of Atacama which accompanied his letters.* All astronomers who have occasion to use the ample information furnished by Mr. King will, I am sure, thank him heartily for the interest he has shown in the success of their researches. It has rarely if ever before happened that eclipse data for a remote region have been so thoroughly and promptly supplied for the benefit of outgoing expeditions.

The Chilean region to the northeast of Merceditas and Cerro Blanco (see map in *Nature*) is not to be neglected, as it presents nearly equal railway facilities, and the chances of clear skies are not much inferior. As the map shows, the observer would land at Caldera, the first port north of Carrizal, and proceed inland by rail to San Antonio, the present terminus, a few miles north of the line of central eclipse. At my request, H. B. Beazley, Esq., H. B. M.'s Vice-Consul at Caldera, very kindly secured the following observations at San Antonio during the month of April, 1892. They were made by Mr. G. Rowe, and the temperature readings are on Reaumur's scale : —

* Also *Astronomy and Astrophysics*, XI., 863 (December, 1892).

OBSERVATIONS AT SAN ANTONIO, COPIAPÓ, CHILE, DURING APRIL, 1892.

| Day. | 7.45 A. M. | 8.45 A. M. | 2 P. M. | Remarks. |
|---|---|---|---|---|
| April 1 | 12 | 15 | 23 | No clouds during the day. |
| " 2 | 11 | 14 | 22½ | " " " " " |
| " 3 | 12 | 15 | 22½ | " " " " " |
| " 4 | 13 | 16 | 23 | " " " " " |
| " 5 | 13 | 15 | 22 | After 10 A. M., thin clouds; sun visible all the day. |
| " 6 | 12 | 14 | 22½ | No clouds during the day. |
| " 7 | 11 | 14 | 22 | " " " " " |
| " 8 | 10 | 15 | 22 | " " " " " |
| " 9 | 11 | 15 | 23 | " " " " " |
| " 10 | 11 | 15 | 23 | After 1 P. M., thin clouds all the day; sun not quite visible. |
| " 11 | 13 | 14 | 20 | Cloudy all day. |
| " 12 | 11 | 13 | 20 | No clouds during the day. |
| " 13 | 11 | 13 | 20 | " " " " " |
| " 14 | 10 | 14 | 21 | " " " " " |
| " 15 | 10 | 14 | 22 | " " " " " |
| " 16 | 11 | 15 | 22 | " " " " " |
| " 17 | 10 | 14 | 21 | " " " " " |
| " 18 | 9½ | 13 | 20 | " " " " " |
| " 19 | 10 | 14 | 20 | Morning cloudy; after 10 A. M., clear sky. |
| " 20 | 7 | 11½ | 18½ | No clouds during the day. |
| " 21 | 9 | 11½ | 18 | Very thin fog or mist; sun visible. |
| " 22 | 9 | 11 | 18 | Very clear sky. |
| " 23 | 8 | 11 | 18 | " " |
| " 24 | 9 | 12 | 19 | " " |
| " 25 | 6 | 10 | 19 | " " |
| " 26 | 6 | 9 | 20 | After 11 A. M., very thin clouds; sun visible all day. |
| " 27 | 8 | 10 | 18 | Thin clouds all day. |
| " 28 | 8 | 10 | 20 | No clouds during the day. |
| " 29 | 8 | 10 | 20 | " " " " " |
| " 30 | 7 | 11 | 20 | " " " " " |

Mr. Beazley has forwarded the following series, also made at San Antonio, by Mr. William Rowe: —

CLOUD OBSERVATIONS AT SAN ANTONIO, CHILE, 1892.

| Day. | Local Time. 7.45 A. M. | 8.15 A. M. | 8.45 A. M. | Remarks. |
|---|---|---|---|---|
| April 1 | 0 | 0 | 0 | Sun shining on all the surrounding hills. |
| " 2 | 0 | 0 | 0 | " " " " |
| " 3 | 0 | 0 | 0 | " " " " |
| " 4 | 0 | 0 | 0 | " " " " |
| " 5 | 0 | 0 | 0 | " " " " |
| " 6 | 0 | 0 | 0 | " " " " |
| " 7 | 0 | 0 | 0 | " " " " |
| " 8 | 0 | 0 | 0 | " " " " |
| " 9 | 0 | 0 | 0 | " " " " |
| " 10 | 0 | 0 | 0 | " " " " |
| " 11 | 1 | 1 | 1 | At intervals. |
| " 12 | 0 | 0 | 0 | No clouds. |
| " 13 | 0 | 0 | 0 | " " |
| " 14 | 0 | 0 | 0 | " " |
| " 15 | 0 | 0 | 0 | " " |
| " 16 | 0 | 0 | 0 | " " |
| " 17 | 0 | 0 | 0 | " " |
| " 18 | 0 | 0 | 0 | " " |
| " 19 | 1 | 1 | 1 | Sun visible. |
| " 20 | 0 | 0 | 0 | No clouds. |
| " 21 | 0 | 0 | 0 | Very thin fog or mist. |
| " 22 | 0 | 0 | 0 | No clouds. |
| " 23 | 0 | 0 | 0 | " " |
| " 24 | 0 | 0 | 0 | " " |
| " 25 | 0 | 0 | 0 | " " |
| " 26 | 0 | 0 | 0 | " " |
| " 27 | 1 | 1 | 1 | Sun visible. |
| " 28 | 0 | 0 | 0 | Very clear sky. |
| " 29 | 0 | 0 | 0 | " " " |
| " 30 | 0 | 0 | 0 | " " " |

0 To mean sun entirely clear from clouds. 1 To mean clouds generally scattered. 2 To mean clouds massed about the sun. 3 To mean sun in haze or fog. 4 To mean sun invisible in thick clouds.

CLOUD OBSERVATIONS AT "AMOLANAS," SAN ANTONIO, CHILE, 1892.

| Day. | 7.45 A. M. | 8.15 A. M. | 8.45 A. M. | Remarks. |
|---|---|---|---|---|
| April 1 | 0 | 0 | 0 | |
| " 2 | 0 | 0 | 0 | |
| " 3 | 0 | 0 | 0 | |
| " 4 | 0 | 0 | 0 | |
| " 5 | 3 | 1 | 1 | |
| " 6 | 0 | 0 | 0 | |
| " 7 | 0 | 0 | 0 | |
| " 8 | 1 | 1 | 0 | |
| " 9 | 0 | 0 | 0 | |
| " 10 | 3 | 3 | 3 | |
| " 11 | 1 | 1 | 1 | |
| " 12 | 3 | 3 | 3 | |
| " 13 | 0 | 0 | 0 | 10.25 A. M. until night, clouds from S. to N. |
| " 14 | 0 | 0 | 0 | 12 M. " " " |
| " 15 | 0 | 0 | 0 | 9.11 A. M. " " " |
| " 16 | 0 | 0 | 0 | |
| " 17 | 0 | 0 | 0 | The rest of the days clouded after 10 A. M |
| " 18 | 1 | 1 | 1 | |
| " 19 | 3 | 3 | 3 | |
| " 20 | 1 | 1 | 1 | |
| " 21 | 0 | 0 | 0 | |
| " 22 | 1 | 1 | 1 | |
| " 23 | 0 | 0 | 0 | |
| " 24 | 1 | 1 | 1 | |
| " 25 | 0 | 0 | 0 | |
| " 26 | 0 | 0 | 0 | |
| " 27 | 3 | 3 | 3 | |
| " 28 | 2 | 1 | 1 | |
| " 29 | 3 | 3 | 1 | |
| " 30 | 0 | 0 | 0 | |

0 To mean sun entirely clear from clouds. 1 To mean clouds generally scattered. 2 To mean clouds massed about the sun. 3 To mean sun in haze or fog. 4 To mean sun invisible in thick clouds.

These observations were taken at the mines of "Amolanas," 2,100 metres above level of sea, and at "Antiviaco," 2,500 metres elevation.

The elevation of San Antonio is 3300 feet. Near by are several mountains with easy ascent up to 10,000 feet. From San Antonio to Mount Pulido is a two days' journey. After 11 A. M., the strong winds render it impossible to remain on the summit. The morning sun in April is not more likely to be clear from these summits than from San Antonio, except in case of fogs. If ascent of the mountains is determined upon, there is an abundance of horses and pack mules, but saddles are very scarce. The mules will carry burdens of two hundred and fifty

pounds each. The town of San Antonio is located in a mining and agricultural district, and has about five hundred inhabitants. It is a railway terminus, with telegraph and telephone connections, and train service from Copiapó three days each week. Hotel accommodations are not good, but in special cases suitable arrangements may be made.

All this region of Chile is three or four weeks distant from New York, by the steamships of the Pacific Mail Company, and the Panama Railway to Panama, and thence to Chilean ports by either the Chilean line (South American Steamship Company) or the English line (Pacific Steam Navigation Company). The Pacific Mail Steamships leave New York the 10th, 20th, and 30th of each month. The baggage allowance is two hundred pounds, and the excess rate is six cents per pound to Panama. The cabin rate to Caldera is $267, gold, and excursion tickets are not obtainable. The south bound steamships always stop at Caldera and Carrizal.

The best and most recent large-scale map of this region which I have been able to procure is from Rand, McNally & Company's "Indexed Atlas of the World"; and embraces, on a single folded sheet, Chile, Uruguay, Paraguay, and the Argentine Republic.

ARGENTINE REPUBLIC.

Here are most excellent regions for observing the eclipse-totality several seconds longer than in Chile, and with the added advantage of stations at great altitudes above sea level.

The best general map I have seen is that of Rand, McNally & Company just alluded to. The three provinces available for stations are Catamarca to the west, and Tucuman and Salta to the east. Nearly all the data for this region have been obligingly obtained by Prof. John M. Thome, Director of the Observatorio Nacional Argentino, at Cordoba.

The Lamport and Holt boats make the round trip from New York at a reduction, tickets good for a year. The American boats connect at Rio, with weekly steamers for Buenos Ayres. Trains through to Catamarca via Cordoba, for about $60 of Argentine paper.*

* Also, the United States and Brazil Mail Steamship Company (Mills Building New York) has just established a fortnightly line to Buenos Ayres, from New York without intermediate stop. The quick runs of these steamships will be very favorable for observers desiring to visit the Argentine Republic.

First, the meteorological observations at Mendoza (approximate position, lat. 33° S. long. 68° 40′ west of Greenwich.) This station was selected for cloud observations before the precise track of the eclipse was known; and although it proves to have been too far south, the observations are of value as indicating likely conditions of this general region. The observations during 1891 failed to reach me, having probably miscarried. Following are those for 1890 and 1892: —

OBSERVATIONS MADE IN MENDOZA DURING APRIL, 1890.

| Date. 1890. | Condition of Sky. A. M. | | | | | | | Sun. A. M. | | | | General Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7.30 | 8 | 8.30 | 9 | 9.30 | 10 | 10.30 | 7.30 | 8.30 | 9.30 | 10.30 | |
| April 1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | |
| " 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.30; a few clouds loosely scattered above the horizon in S. S. E. and S. E., later on (9), also in N. W. |
| " 3 | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 0 | 0 | 0 | 3 | After 10 the sky commenced to be suddenly covered with dense clouds. |
| " 4 | 4 | 4 | 3-4 | 3-4 | 3 | 3 | 3-4 | 3 | 3 | 3 | 2 | 7.30; sky clearing up in E. and S. E. After 10.30 clouds disappearing gradually. |
| " 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sky entirely clear all the morning. |
| " 6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 10.30; sky clouding from S. S. W. to S. E. |
| " 7 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 1 | 1 | 0 | 0 | 0 | 0 | 7.30; sky clouding slowly from N. W. to N. E. 9; a few scattered clouds in S. S. W. also. |
| " 8 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | Sky covered with loose clouds. |
| " 9 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | Sky almost covered with clouds which were generally scattered in W. and dense towards E. |
| " 10 | 1 | 1 | 1 | 1 | 1 | 1-0 | 1-0 | 0 | 0 | 0 | 0 | Sky cloudy from W. to S. S. E. |
| " 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | A few clouds above horizon in E. S. E. to S. |
| " 12 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | At 8.30 for a short time clouds were massed about the sun, but in W. and E. they were generally scattered. |
| " 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | All the morning the sky was covered with very light, cirrus clouds. |
| " 14 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0 | 0 | 0 | 0 | A few cirrus clouds towards E. Cloudy horizon from N. W. round N. E. to S. E. |
| " 15 | 4 | 4 | 4 | 4 | 4 | 4-3 | 4-3 | 3 | 3 | 3 | 3 | Sky covered with dense clouds. After 9.30 clearing up a little in N. W. and E. |
| " 16 | 0-1 | 0-1 | 0-1 | 0-1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.30; cloudy horizon in E. After 9 clouds disappearing. |
| " 17 | 2 | 2 | 2-1 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 7.30; W. to N. W. dense clouds, E. generally scattered. After 8.30 sky became covered with light clouds. |
| " 18 | 0 | 0 | 0 | 0 | 0 | 0-1 | 0-1 | 0 | 0 | 0 | 0 | 9; horizon cloudy from S. W. to N. W. 10 to 10.30; light cirrus clouds covering part of western sky. |
| " 19 | 2 | 2-1 | 1 | 1-0 | 1-0 | 1-0 | 1-0 | 1 | 0 | 0 | 0 | 8.30; cloudy horizon from N. E. to S. E. From 9, onwards, very light cirrus clouds were scattered over the sky. |
| " 20 | 1-0 | 1-0 | 1-2 | 2 | 3 | 4 | 4-3 | 1 | 1 | 2 | 2 | 7.30; a few scattered clouds. 9; sky became covered with transparent clouds which disappeared gradually towards 10.30. |
| " 21 | 3 | 3 | 2 | 2 | 2-1 | 1 | 1-0 | 2 | 2 | 1 | 0 | 7.30; cumulus clouds which changed into cirrus clouds and dissolved gradually after 9.30. |
| " 22 | 4-3 | 4-3 | 3 | 3 | 3-2 | 3-2 | 3-2 | 2 | 2 | 2 | 2 | Sky covered with cirrus clouds. After 9.30 clouds slowly disappearing in W. |
| " 23 | 1-0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 7.30; cloudy horizon from W. N. W., round N. E. to S. E. 8.30; western horizon also clouding. |
| " 24 | 0 | 0-1 | 1-2 | 2-1 | 1-0 | 1-0 | 0 | 0 | 2 | 0 | 0 | 7.30 to 10.30; a few scattered clouds in W.; 8 to 10.15; a mass of cirrus clouds passing across the sky from W. S. W. towards E. N. E., keeping its shape all the way. |
| " 25 | 3-4 | 3-4 | 3-4 | 3-4 | 4-3 | 3 | 3-2 | 2 | 2 | 2 | 2 | 7.30; sky covered with cumulus clouds, changing about 8.30 into cirrus in W. and cumulus in E. |
| " 26 | 3-2 | 2 | 2 | 2 | 2-1 | 2-1 | 2-1 | 2 | 2 | 2 | 2 | 7.30; clouds in W. generally scattered, in E. more compact, but not dense. |
| " 27 | 3-4 | 3-4 | 3-4 | 3-4 | 4 | 4 | 4-3 | 1 | 2 | 3 | 3 | 8.30; W. and N. clouds generally scattered. S. and E. cumulus. 9.30; sky covered with cumulus clouds. |
| " 28 | 3-2 | 3-2 | 3-2 | 3-2 | 3-2 | 3-2 | 3-2 | 1 | 2 | 1 | 1 | 8.30; clouds generally scattered in W., otherwise dense. |
| " 29 | 4 | 4 | 4 | 4 | 4 | 4-3 | 4-3 | 3 | 3 | 3 | 3 | Sky covered with dense, partly nimbus, clouds. |
| " 30 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | Sky covered with dense clouds. |

Explanation of Symbols.

*For the Sky.*

Sky entirely clear — 0.
Sky ¼ overclouded — 1.
Sky ½ overclouded — 2.
Sky ¾ overclouded — 3.
Sky all overclouded — 4.

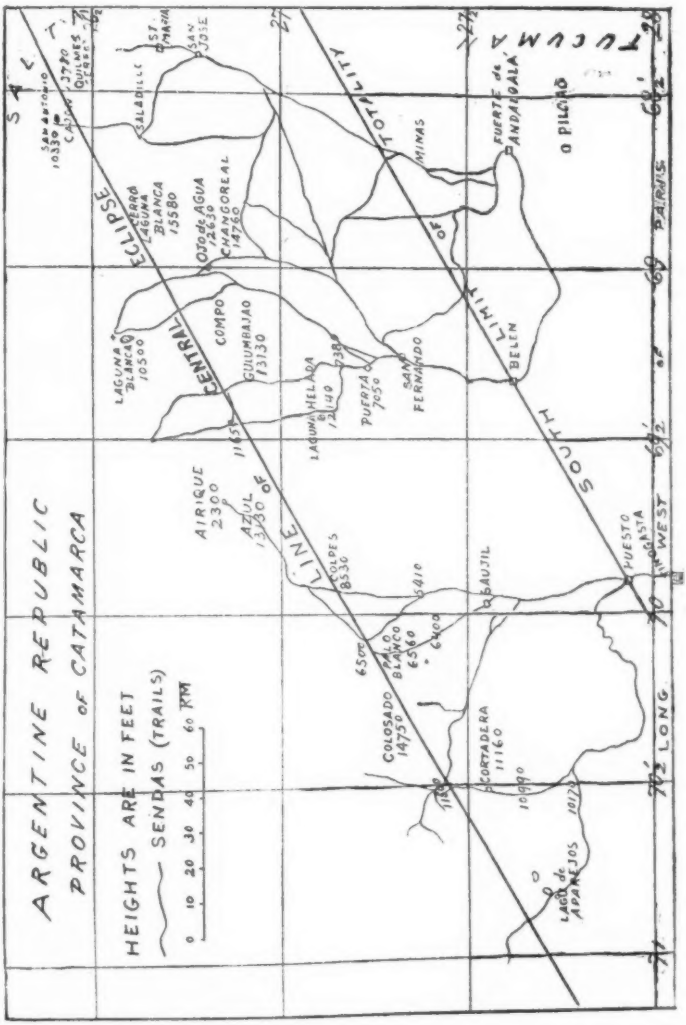
*For the Sun.*

0. — Sun clear from clouds.
1. — Clouds generally scattered.
2. — Clouds massed about the sun.
3. — Sun invisible.

OBSERVATIONS MADE IN MENDOZA DURING APRIL, 1892.

| Date. 1892. | Condition of Sky. A. M. | | | | | | | Sun. A. M. | | | | General Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7.30 | 8 | 8.30 | 9 | 9.30 | 10 | 10.30 | 7.30 | 8.30 | 9.30 | 10.30 | |
| April 1 | 3 | 3 | 3 | 3-2 | 3-2 | 3-2 | 3-2 | 3 | 3 | 3 | 3 | Weather rainy, at 9 beginning to clear up in E. |
| " 2 | 1-0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | A few clouds loosely scattered in the sky. |
| " 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | A few clouds loosely scattered in the sky. |
| " 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| " 5 | 3 | 3-4 | 3 | 3-2 | 3-2 | 2 | 2 | 0 | 3 | 1-0 | 0 | About 8.30 a rising breeze clears the sky. Cirrus clouds. |
| " 6 | 2-1 | 2-1 | 2-1 | 2-1 | 2-1 | 2-1 | 2-1 | 2 | 2 | 2 | 2 | N. E. to N. W. overclouded (cirrus). |
| " 7 | 2 | 2-1 | 2-1 | 1 | 1 | 1-2 | 1-2 | 0 | 0 | 0-1 | 0-1 | After clearing up a little between 8 to 9.30, sky covered again. |
| " 8 | 4-3 | 4-3 | 4-3 | 3 | 3-4 | 3 | 3 | 3-2 | 3 | 3 | 3 | From 9 onwards clearing up towards S. |
| " 9 | 3-2 | 3-2 | 3-2 | 3-2 | 3-2 | 3-2 | 3-2 | 1 | 1 | 1 | 1 | 8 o'clock; from zenith to S. a few clouds only. |
| " 10 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 | 7.30 to 8; W. horizon clearing a little for a short time |
| " 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Horizon, S. N. and especially E. lined with clouds. |
| " 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Few clouds scattered all over the sky. |
| " 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| " 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| " 15 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | Dense cumulus clouds covering sky all day long. |
| " 16 | 2-1 | 2-1 | 2-1 | 2-1 | 3-2 | 3-2 | 3-2 | 1-0 | 1-0 | 1-0 | 1-0 | Transparent cirrus clouds. |
| " 17 | 1-0 | 1-0 | 1-0 | 1-0 | 1-0 | 1-0 | 1-0 | 0 | 0-1 | 0-1 | 0-1 | On S. horizon a few clouds. |
| " 18 | 4-3 | 4-3 | 4-3 | 4-3 | 4-3 | 4-3 | 4-3 | 1 | 1 | 1 | 1 | Nearly totally covered with light cirrus clouds. |
| " 19 | 3 | 3 | 3-4 | 4 | 4 | 4 | 4 | 0 | 1-2 | 3 | 3 | 10 o'clock; thunder storm. |
| " 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Until 9.30 a few clouds on S. and N. horizon, later on in E. |
| " 21 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | Dense cumulus clouds. |
| " 22 | 1-0 | 1-0 | 1-0 | 1-0 | 1-0 | 1-0 | 1-0 | 0 | 0 | 0 | 0 | Horizon lined with clouds. |
| " 23 | 3-2 | 3-2 | 2 | 2-1 | 1-0 | 1-0 | 1-0 | 1 | 0 | 0 | 0 | 8.30; clearing up, and later on clouds above W. and S. horizon. |
| " 24 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | Shortly before closing observation it clears up a little. |
| " 25 | 1-0 | 1-0 | 1-0 | 1-0 | 1-0 | 1-0 | 1-0 | 0 | 0 | 0 | 0 | |
| " 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| " 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| " 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| " 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| " 30 | 3-4 | 3-4 | 3-4 | 3-4 | 3-4 | 3-4 | 3-4 | 3 | 3 | 3 | 3 | Cumulus clouds in E., other part of sky clouds scattered. |

*Catamarca.* — Though less accessible than Tucuman and Salta, this province is much the best meteorologically. The moun-




tain stations on the accompanying map are reached by easy trails from the south, the railway terminating at the town of

Catamarca, whence the trails to the mountains extend through Tinogasta. Also it is accessible from the northeast via Salta, the present terminus of the main line from Buenos Ayres and Cordoba.

Some of the plains in the province of Catamarca have an elevation of from 4,000 to 6,000 feet; and upon the Gulumpajao mountains, 12,000 to 13,000 feet, it is said never to rain, and the skies are mostly clear.

Mr. Lafone, a wealthy Englishman, resident in this region about twenty years and who owns smelting works in Pilciao and Andalgalá, has a good knowledge of the thinly settled country to the north, and his advice and recommendation will be invaluable. Also Mr. Lange, for a time adjunct to one of the U. S. surveying parties in the Rocky Mountains, is now publishing a map of the province from pretty complete surveys made by himself, and can give additional and valuable information. The outline map here given is made up from these surveys.

Mr. Lafone writes that April is the very best time for the clearest atmosphere and most brilliant days in this region; and only by an exceptional misfortune can the observers be disappointed.

The drawback in the Catamarca region is the scarcity of wood and water, which are only found low down. At La Puerta both would have to be provided for, and the temperature in April is very low. This year (1892) has been exceptionally cloudy — the most since 1870. The conditions next year are sure to be better in all parts, probably greatly better.

All bills in the region of Cordoba are payable in paper, the dollar — *un peso Nacional* — being worth about twenty-five cents of United States money in May, 1892.

From Mr. Lange the information is obtained that pack mules can be had for thirty *pesos* a month, *peons* (laborers) for fifteen to twenty dollars, and the cost of keep would be about one half *peso* per day for each man and mule. These would need to be contracted for with an *arriero* (muleteer) in the city of Catamarca. Tents or houses would have to be brought with the party, everything of that sort being very dear.

Mr. Lange, having been all over this region, knows what to expect at each point, as well as how to reach it. The following information is given in his own words:—

"I travelled through this region during the months of April and May of last year (1891). The weather was generally clear and quite cold (reaching 6° below zero Centigrade in the early mornings). There were occasionally strong winds. It seems to me better not to attempt the highest peaks, where the cloudiness is more frequent than on the slopes and lower plateaus. Good places for stations would be (see map):—

"1. The pass to the north of Gulumpajao.

"2. The plains to the north of Compo.

"3. The plains at the head of Laguna Blanca.

"4. The Cerro Laguna Blanca.

"5. Cerro Quilmes.

"The expedition ought to go to Andalgalá for outfit, *peons*, animals, etc. Guides must be sought in the neighborhood of the various stations. In La Puerta, to the north of San Fernando, lives my friend D. Ricardo Aibar, lieutenant of camp police, to whom I could give a letter of recommendation.

"It ought to be possible to get *peons* for twenty dollars per month, and food about ten or twelve dollars more. Pack mules for ten to fifteen dollars per month.

"My map will be printed by the end of this year (1892)."

The eclipse region is very thinly populated by an indifferent class. The towns indicated on the map are mere straggling ranches, the country is very barren, and but few if any comforts are to be found. Both fuel and water must be taken into account when selecting a camp. The heat during January and February is very great, except at the higher elevations. A supply of canned meats and fruits and milk should be taken, as the usual food is rice broth and roast mutton or kid. No bread, coffee, sugar, nor lemonade. At Pilciao, where Mr. Lafone resides, it would be possible to live in comparative comfort, and to purchase all things needful for absolute use in camp. The national telegraph lines, connecting with the Observatorio Nacional Argentino, pass through Pilciao, Andalgalá and Belen. The sky when cloudless is of exceptional transparency.

*Tucuman and Salta.* — These towns, both accessible by rail from Buenos Ayres, are located just outside the belt of total eclipse, Tucuman to the south and Salta to the north. But the cloud conditions are not likely to be very different at Rosario

de la Frontera, a little settlement also on the railroad about midway between Tucuman and Salta, and quite precisely situate on the line of central eclipse. The railway stations near Rosario are at about 2,000 feet elevation. It will be seen that April is not a good month here ; and it will not be very different at Cajon, a summit of perhaps 12,000 feet elevation in southwest part of Salta, and also very near the central line.

The past ten years' observations at Tucuman give the following cloud-results for the days, April 10–16. Scale of 10.

Number of days (mean results from three daily observations):

| | Without Clouds. | Partially Cloudy. | Completely Cloudy. | Mean Daily Cloudiness. |
|---|---|---|---|---|
| April 10 | 1 | 8 | 1 | 5 |
| " 11 | 2 | 5 | 3 | 8 |
| " 12 | 1 | 7 | 2 | 8 |
| " 13 | 0 | 8 | 2 | 4 |
| " 14 | 1 | 8 | 1 | 1 |
| " 15 | 2 | 8 | 0 | 1 |
| " 16 | 1 | 7 | 2 | 8 |

From Salta, for the same interval, we have, number of days:

| | Without Clouds. | Partially Cloudy. | Completely Cloudy. | Mean Daily Cloudiness. |
|---|---|---|---|---|
| April 10 | 0 | 7 | 3 | 9 |
| " 11 | 1 | 7 | 2 | 5 |
| " 12 | 0 | 6 | 4 | 10 |
| " 13 | 0 | 6 | 4 | 6 |
| " 14 | 0 | 8 | 2 | 2 |
| " 15 | 1 | 7 | 2 | 5 |
| " 16 | 1 | 7 | 2 | 6 |

The above data were furnished by Mr. Davis, director of the Argentine Meteorological Office at Cordoba.

Following are additional cloud observations at these two stations :—

TUCUMAN.

| | April, 1890. | | April, 1891. | | | April, 1892. | | |
|---|---|---|---|---|---|---|---|---|
| | 7 A. M. Cloudiness. | 2 P. M. Cloudiness. | | 7 A. M. Cloudiness. | 2 P. M. Cloudiness. | | 7 A. M. | 2 P. M. | 9 P. M. |
| April | | | April | | | April | | | |
| 1 | 8 C. K. | 5 C. K. | 1 | 7 K | 3 K. | 7 | 4 | 3 | 2 |
| 2 | 0 – | 5 K. | 2 | 10 N. | 10 N. | 8 | 10 | 10 | 10 |
| 3 | 9 C. S. | 8 C. K. | 3 | 1 C. K. | 5 K. | 9 | 7 | 3 | 8 |
| 4 | 10 N. | 10 N. | 4 | 10 N. | 7 C. K. | 10 | 3 | 8 | 8 |
| 5 | 7 N. Cumulus. | 7 K | 5 | 10 N. | 7 K. N. | 11 | 10 | 10 | 10 |
| 6 | 0 – | 0 – | 6 | 10 N. | 10 N. | 12 | 10 | 10 | 5 |
| 7 | 0 – | 2 K. | 7 | 10 N. | 10 N. | 13 | 7 | 4 | 4 |
| 8 | 8 C. K. | 3 K. | 8 | 3 C. | 6 K. N. | 14 | 0 | 3 | 3 |
| 9 | 0 – | 5 C. K. | 9 | 0 – | 3 K. | 15 | 0 | 4 | 10 |
| 10 | 10 K. N. | 9 K. N. | 10 | 0 – | 5 C. K. | 16 | 10 | 10 | 10 |
| 11 | 0 – | 0 – | 11 | 10 C. K. | 5 C. K. | | | | |
| 12 | 0 – | 0 – | 12 | 10 K. N. | 9 K. N. | | | | |
| 13 | 8 C. K. | 0 – | 13 | 7 C. K. | 4 K. | | | | |
| 14 | 2 C. K. | 3 C. K. | 14 | 0 – | 1 K. | | | | |
| 15 | 0 – | 7 K | 15 | 0 – | 2 C. K. | | | | |
| 16 | 0 – | 3 K | 16 | 7 C. K. | 8 C. K. | | | | |

SALTA.

| | April, 1890. | | April, 1891. | | | April, 1892. | |
|---|---|---|---|---|---|---|---|
| | 7 A. M. Cloudiness. | 2 P. M. Cloudiness. | | 7 A. M. Cloudiness. | 2 P. M. Cloudiness. | | |
| April | | | April | | | April | |
| 1 | 10 C. Stratus. | 8 N. | 1 | 8 C. | – – | 8 | Cloudy all day. |
| 2 | 0 – | – C. S. | 2 | 10 N. | – – | 9 | " " |
| 3 | 1 S. | – – | 3 | 10 N. | 10 C. K. | 10 | " " |
| 4 | 6 Cirrus. | 10 N. | 4 | 10 N. | – – | 11 | " all forenoon. |
| 5 | – – | – – | 5 | 10 K. S. | 10 K. S. | 12 | Cloudy all day. |
| 6 | 0 – | – – | 6 | – – | 10 N. | 13 | 7 A. M., 5; 2 P. M., 6; 9 P. M., 3. |
| 7 | 6 S. | – – | 7 | 10 N. | 10 N. | 14 | Clear all day. |
| 8 | 9 S. | – – | 8 | 10 K. S. | 10 K. S. | 15 | " " |
| 9 | 0 – | 3 C. | 9 | 10 K. S. | 1 C. K. | 16 | Cloudy all day. |
| 10 | 9 Nimb. | 6 C. | 10 | 10 K. S. | 10 K. S. | 17 | " " |
| 11 | 0 – | 9 S. | 11 | 9 K. S. | 6 K. | | |
| 12 | 0 – | 9 – | 12 | 10 K. S. | 10 K. S. | | |
| 13 | 0 – | 7 C. S. | 13 | 9 C. S. | 8 K. | | |
| 14 | 0 – | 6 – | 14 | 0 – | 2 K. | | |
| 15 | 6 S. | 2 | 15 | 1 C. | 8 C. S. | | |
| 16 | 1 C. | 5 C. | 16 | 10 C. S. | 4 K. | | |

From these data, it is quite apparent that the chances of clear skies at Rosario de la Frontera are by no means comparable with its accessibility.

PARAGUAY.

As was to be expected, the effort to secure meteorological data for northern Paraguay has been utterly futile. However, the region is a choice and attractive one, particularly if the visiting astronomer is a good hunter as well. The fullest information about the country, with a very accurate map, is given in a work just published by Charles Scribner's Sons, New York, and George Philip & Son, London.

At pp. 71–73*, the climate is treated in a general way. The eclipse takes place in the dry season, and the chances of a clear sky are inferably good. The climate is salubrious, and the ascent of the Upper Paraguay would not be unmixed with adventure.

A competent naturalist and anthropologist should accompany the expedition, as they might secure plenty of pumas, tapirs, canidae, jaguars, cobras, cross-vipers, and the like, to offset the possible loss of the corona to the astronomer. Ascending the upper Paraguay to latitude 21° 11′, the line of central eclipse is intersected, at a point about ten miles south of Fuerte Olimpo. Here the river divides Brazil from Paraguay Occidental. Totality is 3m. 33s. in duration; and the famous Pan de Azucar, a mountain on the Brazilian bank, and estimated by Mouchez to be 1,200 feet in height, would doubtless form an excellent observing station. It is about twelve miles south of the central line, a distance which would subtract only a few seconds from the duration of total phase. To the west of the Paraguay, this region is inhabited by Indians of the tribe known as Angaïtes. (De Bourgade, p. 35.)

BRAZIL.

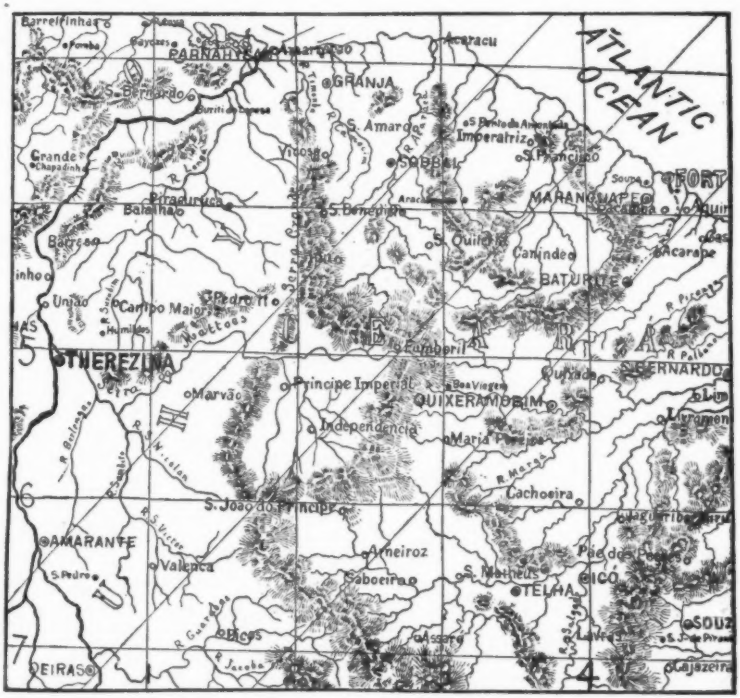
Meteorological indications for the interior of Brazil have not been obtainable. On the coast, however, the cloud probabilities are such that it is extremely desirable to have additional parties established in the interior. Two routes and localities are feasible.

*Palma.*— To reach this locality, the party would land at Belem (Para), and ascend the Rio Tocantins to its junction with the Rio Palma. Then, a short distance easterly on this latter

* Paraguay: The Land and the People, Natural Wealth and Commercial Capabilities. By Dr. E. De Bourgade la Dardye. English Edition edited by E. G. Ravenstein, F. R. G. S. 1892.

stream is the town of Palma. The place itself is about twenty miles northwest of the line of central eclipse, on which the duration of totality is 4m. 10s.

*Oeiras.* — This town is much more available. Land at Parnahyba, ascend the river of the same name as far as Amarante, and from thence the Rio Caninde to Oeiras. The town is almost exactly on the central line, and the duration of totality 4m. 32s.




Oeiras is shown in the southwest corner of the accompanying map, a photographic reproduction from the "Carta Physica do Brazil Mostrando os Systhemas Orographico e Hydrographico d'Esta Regiao." Por F. M. Homem de Mello. Rio de Janeiro, 1875. The meridians are counted east from Rio de Janeiro, which is 43° 10′ 20″ west of Greenwich.

*Ceara.*—Dr. L. Cruls, director of the Observatorio do Rio de Janeiro, has courteously responded to my request for

cloud-observations in the province of Ceara, and the summary of results here presented for April, 1891, is taken from the monthly "Revista do Observatorio,' Anno vi, pp. 66–69 : —

RESULTS OF OBSERVATIONS AT FORTALEZA, THE CAPITAL OF THE STATE OF CEARA, BRAZIL.

| Date. 1891. | Rainfall. | Cloudiness. | Day. | Rainfall. | Cloudiness. |
|---|---|---|---|---|---|
| | mm. | | | mm. | |
| April 1 | 3.5 | 4.3 | April 16 | – | 1.6 |
| " 2 | 28.6 | 7.0 | " 17 | – | 2.6 |
| " 3 | 24.5 | 7.0 | " 18 | 5.0 | 2.3 |
| " 4 | 7.5 | 6.0 | " 19 | 25.0 | 10.0 |
| " 5 | 5.5 | 7.6 | " 20 | 1.5 | 5.3 |
| " 6 | 2.5 | 7.3 | " 21 | 4.0 | 9.0 |
| " 7 | 41.5 | 10.0 | " 22 | 21.5 | 10.0 |
| " 8 | 8.0 | 9.6 | " 23 | 10.8 | 10.0 |
| " 9 | – | 4.0 | " 24 | 42.0 | 8.3 |
| " 10 | – | 3.0 | " 25 | 5.0 | 6.3 |
| " 14 | 10.3 | 7.6 | " 26 | – | 8.3 |
| " 12 | 8.0 | 9.0 | " 27 | 1.0 | 4.3 |
| " 13 | – | 7.6 | " 28 | – | 5.0 |
| " 14 | 6.5 | 5.0 | " 29 | – | 3.0 |
| " 15 | – | 3.6 | " 30 | – | 6.0 |

For the month, then, —

| | |
|---|---|
| Number of rainy days | 20 |
| Amount of rain | 262. 2 mm. |
| Mean cloudiness | 6.48 |

BY DECADES.

| | mm. | | |
|---|---|---|---|
| *First* | 131.6 rain | Mean cloudiness | 6.58 |
| *Second* | 56.3 rain | Mean cloudiness | 5.46 |
| *Third* | 84.3 rain | Mean cloudiness | 7.42 |

CLOUD-OBSERVATIONS AT FORTALEZA, CEARA, 1891.

| Date. 1891. | State of the Sky. | | | Date. 1891. | State of the Sky. | | |
|---|---|---|---|---|---|---|---|
| | 9 A. M. | 12 M. | 3 P. M. | | 9 A. M. | 12 M. | 3 P. M. |
| April 1 | 0.8 N. 0.2 K. | 0.5 K. | 0 | April 16 | 0.5 K. | 0 | 0 |
| " 2 | 0.8 N. 0.2 K. | 0.8 N. | 0.5 N. | " 17 | 0.8 K. | 0 | 0 |
| " 3 | 0.8 N. 0.2 K. | 0.8 K. S. | 0.5 N. | " 18 | 0.5 K. | 0 | 0.2 K. |
| " 4 | 0.5 K.N. | 0.8 K. | 0.5 K. S. | " 19 | K. N. | – | – |
| " 5 | 0.9 K. | 0.6 K. S. | 0.8 K. S. | " 20 | 0.5 K. | 0.8 K. | 0.3 K. |
| " 6 | 0.8 K. | 0.8 K. | 0.6 K. | " 21 | K. N. | 0.8 K. | – |
| " 7 | – | N. | N. | " 22 | K. S. | 0.5 K. | K. S. |
| " 8 | K. S. | K. N. | 0.9 K. | " 23 | K. N. | K. N. | K. N. |
| " 9 | 0.4 K. S. | 0.4 K. | 0.4 K. | " 24 | K. N. | N. | N. |
| " 10 | 0.5 K. | 0.3 K. | 0.1 K. | " 25 | K. S. | K. N. | 0.5 K. |
| " 11 | K. | 0.5 K. | 0.8 K. | " 26 | 0.5 K. | 0.4 K. | K. S. |
| " 12 | 0.9 K. | 0.9 K. | – | " 27 | 0.5 K. | 0.5 K. | 0.3 K. |
| " 13 | K. N. | 0.8 K. | 0.5 K. | " 28 | 0.8 K. | 0.5 K. | 0.2 K. |
| " 14 | 0.5 K. | 0.8 K. | 0.2 K. | " 29 | 0.6 K. | 0.5 K. | K. S. |
| " 15 | 0.9 K. | 0.2 K. S. | 0 | " 30 | 0.5 K. | 0.5 K. | 0.8 K.S. |

For further information, the original paper of M. Cruls must be consulted. The cloud observations are by no means as encouraging for a clear totality as could be wished. It is, however, to be observed that in 1891, at noon (the time of the eclipse) on April 15-18, there was little or no cloud visible. M. Cruls has, it is understood, had additional observations made in this region during 1892; but it has not been thought best to delay the publication of this paper longer, in order to present them.

The accompanying sectional map of Northeastern Brazil shows the line of central eclipse, and the north and south limits of total obscuration.*

From the data of the "American Ephemeris" are derived the following times of the eclipse, for that point northwest of Ceara, where the central line intersects the coast: —

| | April 16, 1893. | | | |
|---|---|---|---|---|
| | H. | M. | S. | |
| Beginning of eclipse | 10 | 18 | 23.4 | Local time, A. M. |
| Beginning of totality | 11 | 40 | 23.1 | |
| End of totality | 11 | 45 | 2.5 | |
| End of eclipse | 1 | 11 | 8.0 | P. M. |
| Duration of the total phase | | 4 | 39.4 | |

This point is nearly forty miles from Fortaleza de Ceara.

The ships of the U. S. & Brazil Mail Steamship Company, sailing fortnightly from New York, do not regularly stop at Ceara; but I am informed that the necessary privileges will be extended to parties visiting Ceara for the purpose of observing the eclipse.

Through the courtesy of my colleague, Dr. Edward Hitchcock, who visited Ceara, in June, 1892, I am enabled to present much additional information affecting this general region which is to be so exceptionally favored by the maximum land-duration of the total eclipse.

From Ceara there is a railway built seventy miles into the interior, in a southerly direction. Telegraphic service accompanies the railway.

There is also a carriage road extending about sixty miles to

* Just as this paper is going to press, I have received, through the courtesy of President Ivins, of the U. S. & Brazil Mail Steamship Company, a very recent map of this region, on a scale about four times that of the map here presented, and entitled, "Carta Topographica do Ceara. Palo Professor J. G. Dias Sobreira, 1892."

the south, as far as Baturité, but it does not reach land of any considerable elevation. There are three chains of mountains west of the city; first, Pacatuba, nine miles west of the city, and 800 metres high; second, Maranguape, further west, and 820 metres high; third, Goaga, 600 metres high. The coast line adjacent to Ceara runs northwest.

Any weight up to half a ton could be easily carried first, from the steamer by lighters, and then on men's backs to the railroad, which is close by the beach.

The French Commission have already selected their site at Pecem, the three hills, about twenty-five miles northwest of Ceara.

February, March, and April constitute the rainy season, but the sun shines in the middle of the day. The probability of cloud, back from the coast, at this time, would be greater; that is, a site farther away would be not so good.

There are few photographers at Ceara, the only one Dr. Hitchcock saw being a Dane, who made "tolerably fair pictures."

The place is perfectly healthy and sanitary. "Consumptives come to this region for residence, and always are well ever after." The mountains behind the town have a most inviting look for health.

Common building material is brick, and there are good masons. The markets are excellent, and all the necessaries of life are readily obtained. Cooks and servants could be procured at Ceara; but the hotels are "not kept in New York style." Back in the interior the province is poor, and there is occasional famine from drought.

Among the intelligent residents of Ceara, from whom further information may be obtained, are Dr. Paulino Nogueira Borges da Fonseca, Dr. Thomaz Pompeo da Souza Brazil, and Francisco José do Nascimento, the steamboat pilot.

### ATLANTIC OCEAN.

For the following table of the average cloudiness of each point of the eclipse track, taken from L. Teisserenc de Bort "Cartes des Isonephes," and expressing on a scale of 0–10 the monthly mean of the daily averages for April, I am indebted to Prof. Cleveland Abbe:—

| Totality. Lat. Degrees. | Totality. Long. Degrees. | Cloudiness. 10 = wholly clouded. | Totality. Lat. Degrees. | Totality. Long. Degrees. | Cloudiness. 10 = wholly clouded. |
|---|---|---|---|---|---|
| −4.2 | 39.8 | 6 | +6.8 | 28.5 | 5 |
| 2.9 | 38.5 | 6 | 7.9 | 27.9 | 4 |
| 1.6 | 37.3 | 5 | 9.0 | 25.7 | 4 |
| −0.3 | 36.1 | 5 | 10.1 | 24.1 | 4 |
| +0.9 | 34.9 | 6 | 11.1 | 22.5 | 4 |
| 2.2 | 33.7 | 6 | 12.1 | 20.8 | 3 |
| 3.4 | 32.5 | 7 | 13.1 | 18.9 | 3 |
| 4.5 | 31.2 | 7 | 14.0 | 16.9 | 3 |
| 5.7 | 29.9 | 6 | +14.9 | 14.7 | 3 |

GAMBIA.

For much of the valuable information relating to this region, I have great pleasure in thanking Reginald L. Antrobus, Esq., of the Colonial Office, London, lately acting governor of Saint Helena, who has kindly transmitted a parcel of colonial reports, with authority to make use of them in the preparation of this paper.

The following observations were made at Bathurst, Gambia in 1885:—

| Date. 1885. | Barometer. 10 A. M. | Barometer. 4 P. M. | Thermometer. 7 A. M. | Thermometer. Noon. | Remarks. |
|---|---|---|---|---|---|
| April | | | | | |
| 1 | 29.92 | 29.80 | 69 | 73 | Breeze very strong again. |
| 2 | 29.93 | 29.82 | 63 | 72 | Blowing very hard all night, and continued all day. |
| 3 | 29.91 | 29.80 | 63 | 76 | Blowing very hard all night, and continued all day. |
| 4 | 29.98 | 29.83 | 66 | 78 | Wind shifted to E; strong harmattan. |
| 5 | 29.98 | 29.80 | 70 | 79 | Harmattan wind from S. E. in afternoon; therm., 4 P. M., 85°. |
| 6 | 29.90 | 29.81 | 76 | 79 | Still, warm night; sand flies abundant. |
| 7 | 29.98 | 29.83 | 75 | 78 | Somewhat cooler, but breeze light. |
| 8 | 29.80 | 29.70 | 73 | 80 | Breeze still continues light. |
| 9 | 29.81 | 29.72 | 74 | 81 | Breeze still continues light. |
| 10 | 29.80 | 29.73 | 70 | 77 | Breeze still continues light. |
| 11 | 29.90 | 29.80 | 70 | 77 | Breeze somewhat stronger. |
| 12 | 29.90 | 29.81 | 70 | 78 | Breeze somewhat stronger. |
| 13 | 29.95 | 29.82 | 70 | 75 | Cloudy day, with good breeze. |
| 14 | 29.94 | 29.83 | 70 | 76 | Bright, with pleasant breeze. |
| 15 | 29.92 | 29.80 | 71 | 78 | Less breeze and warmer. |
| 16 | 29.90 | 29.81 | 74 | 88 | Very hot day, with harmattan. |
| 17 | 29.59 | 29.80 | 73 | 80 | Hot; much breeze, but cooler. |
| 18 | 29.91 | 29.79 | 72 | 78 | Breeze stronger from the sea. |
| 19 | 29.95 | 29.80 | 69 | 74 | Much cooler, with strong breeze. |
| 20 | 29.95 | 29.81 | 70 | 73 | Much cooler, with strong breeze. |
| 21 | 29.93 | 29.82 | 70 | 75 | Less breeze, but pleasant. |
| 22 | 29.80 | 29.72 | 72 | 80 | Warmer day, with little breeze. |
| 23 | 29.87 | 29.79 | 76 | 83 | Calm, hot day. |
| 24 | 29.90 | 29.80 | 73 | 76 | Cloudy day and cool; therm., 7 P. M., 70°. |
| 25 | 29.92 | 29.81 | 72 | 75 | Pleasant day and cloudy. |
| 26 | 29.90 | 29.80 | 72 | 76 | Much the same; hazy in the evening. |
| 27 | 29.92 | 29.79 | 72 | 74 | Much the same; hazy in the evening. |
| 28 | 29.95 | 29.81 | 69 | 71 | Very cool day; hazy and damp; therm., 68° at 9 P. M. |
| 29 | 29.95 | 29.80 | 66 | 69 | Same as yesterday, only lower temperature. |
| 30 | 29.95 | 29.79 | 66 | 68 | Overcast up to 9 P. M.; stronger breeze after; very cool; therm., 9 A. M., 66°; mean for month, 7 A. M., 70.5°; noon, 76.5°. |

I have also to thank His Excellency R. B. Llewelyn, C. M. G., Government Administrator of the Gambia, for the collection of important observations which follow: —

COMPARATIVE RAINFALL IN THE COLONY OF THE GAMBIA.

| Month. | 1887. | 1888. | 1889. | 1890. | 1891. |
|---|---|---|---|---|---|
| January, | – | .02 | – | – | .01 |
| February, | – | – | – | – | .16 |
| March, | – | – | – | – | – |
| April, | – | – | – | – | – |
| May, | .23 | – | – | .04 | .53 |
| June, | 1.67 | .58 | 1.16 | 2.40 | 4.67 |
| July, | 11.38 | 8.54 | 3.23 | 16.42 | 7.42 |
| August, | 19.82 | 13.47 | 15.57 | 19.90 | 18.84 |
| September, | 13.70 | 9.71 | 10.65 | 16.58 | 19.81 |
| October, | 7.16 | 6.77 | 1.45 | 4.97 | 1.97 |
| November, | – | – | – | – | – |
| December, | – | – | – | – | – |
| | 53.96 | 39.09 | 32.06 | 60.31 | 53.41 |

Average, 47.76.

GAMBIA STATION, BATHURST.

| Months. | Rainfall. | | | Months. | Rainfall. | | |
|---|---|---|---|---|---|---|---|
| 1890. | Total. | Max. | Date. | 1890. | Total. | Max. | Date. |
| January, | – | – | – | July, | 16.42 | 2.65 | 29 |
| February, | – | – | – | August, | 19.90 | 5.20 | 6 |
| March, | – | – | – | September, | 16.58 | 4.82 | 13 |
| April, | – | – | – | October, | 4.97 | 0.75 | 23 |
| May, | 0.04 | 0.04 | 22 | November, | – | – | – |
| June, | 2.40 | 0.98 | 29 | December, | – | – | – |
| Total rainfall for year . . . . . | | | | | | | 60.31 |

METEOROLOGICAL STATISTICS, BATHURST, GAMBIA.

| 1891. Month. | Average for month at 7 A. M. | | | Maximum in shade at 3 P. M. | | | Minimum in shade at 7 A. M. | | | Total rainfall in inches. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dry Bulb. | Wet Bulb. | Dew Point. | Highest. | Lowest. | Average. | Highest. | Lowest. | Average. | |
| July, | 87.8 | 76.2 | 74.5 | 92° | 82° | 86.7 | 78° | 68° | 73.4 | 7.42 |
| August, | 76.8 | 75.4 | 74.2 | 88° | 75° | 83.7 | 75° | 70° | 72.7 | 18.84 |
| September, | 77.3 | 75.1 | 73.6 | 90° | 80° | 85.9 | 75° | 69° | 72.3 | 19.81 |
| October, | 77.5 | 75.4 | 73.5 | 90° | 83° | 87.4 | 77° | 69° | 73.1 | 1.97 |
| November, | 73.4 | 67.8 | 63.8 | 90° | 80° | 84.4 | 74° | 64° | 68.8 | – |
| December, | 69.8 | 63.3 | 58.4 | 92° | 80° | 84.7 | 68° | 62° | 65.7 | – |

## OBSERVATIONS OF THE SKY DURING THE MONTH OF APRIL, 1892.

| Date. | General Condition of the Sky. Local Time, P. M. | | | | | | | Sky Surrounding the Sun. Local Time, P. M. | | | | | | | General Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| April. | 1.00. | 1.30. | 2.00. | 2.30. | 3.00. | 3.30. | 4.00. | 1.00. | 1.30. | 2.00. | 2.30. | 3.00. | 3.30. | 4.00. | |
| 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | Light fleecy clouds; hazy generally. |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Slightly hazy on the horizon. |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Faint clouds on the S. Eastern horizon. |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Light clouds (very faint). |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 8 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Very transparent clouds. |
| 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 11 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 13 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | Sun visible for about 5 min. between 2.30 and 3. |
| | | | | | | | | At Cape St. Mary. | | | | | | | |
| 14 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 16 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 17 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | Cloudy generally, with very strong wind. |
| 18 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | |
| 19 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 0 | 0 | 1 | Slight shower at 7.30 A. M.; very cloudy in early morning. |
| 20 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | Bathurst. | | | | | | | |
| 21 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| 22 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 0 | 0 | 1 | 2 | 3 | 3 | 2 | |
| 23 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | |
| 24 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | |
| 25 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26 | 0 | 0 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 2 | 2 | 1 | 1 | 0 | Clouds at no time very heavy. |
| 27 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29 | 0 | 0 | 2 | 3 | 2 | 2 | 2 | 0 | 0 | 1 | 2 | 1 | 2 | 2 | Very transparent clouds. |
| 30 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | |

*For the above use the following numbers :* —

| Sky. | Sun. |
|---|---|
| 0 — Sky entirely clear. | 0 — Sun clear from clouds. |
| 1 — ¼ clouded. | 1 — Clouds generally scattered. |
| 2 — ½ clouded. | 2 — Clouds massed about the sun. |
| 3 — ¾ clouded. | 3 — Sun invisible. |
| 4 — Wholly clouded. | |

Further data for this region, meteorological and other, will be found in *Nature*, No. 1183 (30th June, 1892), pages 201-3, where an excellent large-scale map of this particular region of the African coast is given. See also "Astronomy and Astro-Physics," August, 1892, page 562.

Joal and Palmerin, the points of maximum totality on the African coast, are only a few miles removed from Bathurst and Cape St. Mary. Doubtless the meteorological conditions at the former stations will not be remotely unlike those at the latter.

### SENEGAL AND SAHARA.

Of cloud conditions in the interior of Senegal and Sahara, it has been impossible to ascertain anything.

A magnificent map of the African eclipse region has recently been published, —" Spezial-Karte von Afrika in maas-stab von 1 : 4,000,000 (Gotha: Justus Perthes, 1892), Sektion 4." From this map the entire feasibility of an expedition to the interior is apparent. There is no need to say that such an expedition, if equipped with photographic instruments precisely like those to be employed in Chile, would afford perhaps the most significant contribution to solar physics in recent years. There would be little hardship in reaching a station distant three hours of absolute time from Chile, as the lunar shadow travels. The atmospheric conditions of the African desert would likely be very similar to those in the Chilean desert of Atacama, —a very important consideration, and one not likely to be so well fulfilled in any other eclipse for the next half century. Thus the significant question of short-period variations of the corona (systematically attacked by the Russian and Japan expeditions of 1887, and the Guiana and West African expeditions of 1889, with the accident of failure in both instances owing to the prevalence of clouds at the critical moments), might be definitively settled.

Amherst College Observatory, Massachusetts,
1st December, 1892.

## A BALLOON ASCENSION.

PROF. H. A. HAZEN.

ON Oct. 27, 1892, during one of the driest times ever known at Washington city, it was decided by the government experimenters on rain-making to make an ascension to determine the conditions of the atmosphere. The balloon used had a capacity of a little less than 11,000 cubic feet, and when inflated with hydrogen was able to lift two observers and sixty pounds of ballast. It is doubtful if such a small balloon has ever made so high a voyage with such a load. The gas, after passing through iced water, was conveyed by a cloth tube some forty feet long to the balloon, so that its temperature was that of the air. The start was at 15.33, and the first 3000 feet was made in about six minutes. In fourteen minutes we were at nearly 5000 feet, and here the balloon, having lost some gas at the neck, poised for about six minutes and then fell rapidly nearly 1000 feet, when a liberal use of ballast caused its ascension to the highest point attained, 9,400 feet at 16.26. At the high level we remained seven or eight minutes and then returned to *terra firma* quite rapidly. We landed at 16.59, two miles east of Suitland, Md., on the farm of E. D. Rude, having gone 9.4 miles in a nearly due east direction.

The most interesting observation, in some respects, was that of the temperature of the gas. Mr. Ellis and I both thrust our arms into the neck of the balloon at about 5000 feet, as the gas flowed out rather rapidly, and found the temperature a good deal *above* that of the outside air. There was no mistaking this fact. If *all* the buoyancy had been lost through the escape of gas then it would appear as if the balloon should have begun descending at once, while the delay seemed to show that the gas was being cooled by the cold air on the outside. If the gas through expansion, had been colder than the outside air, then the gradual heating of the gas would have caused a greater instead of a less buoyancy. After the landing, Mr. Ellis and myself both carefully felt the gas in the balloon as it rapidly exhausted itself, and it was icy cold. According to theory, the temperature at the centre should have been not far from 60°, or 16° above the air temperature, while it was markedly cooler. I regret that I

had no delicate thermometer for testing the temperature of the gas. It has been suggested that the envelope of the balloon might have retained the temperature of its previous position and this caused the first heat in the gas and the coolness after landing. I had always supposed that the envelope of a balloon, passing rapidly through the air which was thereby continually changed, would keep very near the air temperature; moreover, that the temperature of the gas would be changed more rapidly through convection currents than by conduction. Both of these points I hope to determine accurately very soon.

In order to get an approximate idea of the rapidity of cooling in the envelope, I stitched together two pieces of cloth in such a way as to leave no air between, then pushed in a very delicate thermometer. This combination I carried back and forth between rooms having a difference in temperature of ten degrees. I found the average change in the first minute, on going from one room to the other, a little over seven degrees. When we consider the doubled cloth and the stagnant air about it, I think the slightly different conditions in the actual balloon would show, if anything, even a less lagging than in this ease. I doubt very much if the dry cloth of a balloon lags more than three degrees behind the air temperature in an ascension of five hundred feet per minute.

It seems to me this is a very important point regarding the temperature of the gas, and the balloon affords a most admirable method for determining the effect upon a gas under the conditions of an ascension. It is to be hoped that æronauts will make an effort to obtain approximate results, both in this country and in Europe. It is probable that a very delicate thermometer, suspended horizontally at the centre of the balloon, may be read by a telescope from the basket.

It may be of interest to note here the proofs of the proposition. *In a rapid ascent or descent, the gas of a balloon always retains the temperature of its previous position*, that is, it is always warmer than the air in an ascent, and cooler in a descent.

*First.* In a rapid ascent, the envelope of the balloon cools rapidly, and if the gas is moist, the moisture condenses on the inside of the envelope and trickles down into the basket. This has been repeatedly observed.

*Second.* The gas remains perfectly clear and transparent,

while it is evident a cloud would form, if there were a great cooling at the centre.

*Third.* The gas issuing from the neck of a balloon in a rapid ascent feels quite warm.

*Fourth.* After a rapid descent, in emptying the balloon at once, the gas feels very cold.

*Fifth.* When moist gas issues from the neck of a balloon, about six inches or more from the neck, there is seen a fine white cloud. This has been noted so many times in France that it has given rise to the expression, "The balloon is smoking his pipe."

*Sixth.* If the gas is dry, it presents every appearance of heated gas as it escapes from the neck.

*Seventh.* If a balloon is anchored after landing, and the gas is allowed to heat up, it is found that the buoyancy increases.

*Eighth.* After making due allowance, a balloon half full of gas would rise to only 16,000 or 17,000 feet if the gas were cooled according to theory; while experience shows that a balloon will rise much higher than it would even if the gas were at the air temperature at the highest point, or to 21,000 or 22,000 feet.

*Ninth.* It is an universal experience, that when a balloon starts to go down, it goes more and more rapidly till it reaches the ground. This can only be accounted for on the supposition that the gas retains the low temperature of the higher points; for, if it should be enormously heated, 5.4° per 1,000 feet, the rapid descent would be very soon checked, if not obliterated.

The accompanying table contains the observations made as rapidly as possible. The computations are made from the observations as recorded, though it is evident that a little allowance must be made for the lagging of the aneroid, and for the interval between swinging the thermometers, reading them, the aneroid, and the watch. At the highest point, I have added fifty feet for the aneroid. The apparent slight effect of the Potomac on the moisture of the air is to be noted. If anything, there was less cloudiness over it than on either side. The saturated stratum, at 8,500 feet, is interesting, as it was less than 500 feet thick, the relative humidity, at 9,400 feet, being thirty per cent less.

The great necessity now is to make more frequent ascensions especially at the time of rain. We ought to learn the behavior of this saturated stratum as rain comes on. How it thickens and descends, etc. The whole voyage demonstrated the beautiful and safe character of such exploration. I am perfectly satisfied that the balloon is to be the salvation of meteorology in the near future. It will emancipate us from the thraldom of

theory and speculation which has been so serious a drawback in the past.

Mr. Ellis, the aeronaut, also made observations of the sling psychrometer which will be published in the final report. The sling psychrometer proved itself a most excellent apparatus, responding promptly to all demands upon it and giving a very accurate record of the exact condition of the air.

OBSERVATIONS DURING THE FIFTH BALLOON ASCENSION, OCT. 27, 1892.

| Time. | Wet. | Dry. | Pressure. | Dew Point. | Rel. Hum. | Height. | Observation. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| 15 25 | 43.4 | 53.3 | 29.65 | 30.5 | 41 | – | – | On ground. |
| 15 33 | – | – | – | – | – | – | – | Started. |
| 36 | 40.7 | 49.7 | 28.65 | 28.8 | 47 | 930 | 1 | |
| 38 | 35.0 | 41.0 | 27 15 | 26.3 | 57 | 2,400 | 2 | |
| 40 | 31.2 | 37.6 | 26.20 | 20.3 | 51 | 3,410 | 3 | |
| 43 | 28.0 | 33.0 | 25.43 | 19.2 | 57 | 4,250 | 4 | |
| 44 | 28.0 | 33.4 | 25.20 | 18.3 | 55 | 4,500 | 5 | Over Potomac River. |
| 46 | 26.0 | 31.0 | 25.00 | 16.6 | 55 | 4,730 | 6 | |
| 53 | 25.0 | 28.7 | 24.80 | 18.6 | 67 | 4,970 | 7 | Water frozen on wet bulb, difficult to get down. |
| 55 | 26.4 | 30.6 | 25.25 | 19.0 | 61 | 4,460 | 8 | |
| 56.5 | 28.8 | 33.0 | 25.65 | 22.0 | 64 | 4,020 | 9 | |
| 16 3 | 24.0 | 26.0 | 24.15 | 20.4 | 77 | 5,730 | 10 | |
| 5 | 21.4 | 24.2 | 23.50 | 15.7 | 71 | 6,500 | 11 | |
| 6 | 20.0 | 21.5 | 23.30 | 17.0 | 81 | 6,760 | 12 | |
| 11 | 17.4 | 18.2 | 22.55 | 15.4 | 89 | 7,710 | 13 | |
| 13 | 17.0 | 17.6 | 22.20 | 15.0 | 91 | 8,150 | 14 | |
| 15 | 15.7 | 15.6 | 21.90 | 15.6 | 100 | 8,550 | 15 | Compression of ice causes wet higher than dry. |
| 17 | 14.2 | 14.0 | 21.70 | 14.0 | 100 | 8,820 | 16 | |
| 19 | 13.9 | 14.7 | 21.55 | 11.0 | 85 | 9,010 | 17 | |
| 21 | 13.0 | 13.4 | 21.40 | 10.7 | 86 | 9,230 | 18 | |
| 23 | 13.0 | 15.2 | 21.35 | 8.0 | 70 | 9,280 | 19 | |
| 25 | 14.2 | 16.6 | 21.37 | 7.5 | 70 | 9,240 | 20 | |
| 26 | 13.4 | 15.8 | 21.30 | 7.5 | 69 | 9,380 | 21 | |
| 28 | 13.2 | 15.3 | 21.30 | 6.9 | 70 | 9,400 | 22 | |
| 30 | 13.0 | 13.6 | 21.40 | 10.7 | 90 | 9,230 | 23 | |
| 32 | 13.1 | 14.0 | 21.44 | 10.1 | 83 | 9,170 | 24 | |
| 34 | 13.4 | 14.0 | 21.55 | 11.4 | 88 | 9,010 | 25 | |
| 38 | 14.3 | 13.8 | 22.05 | 13.8 | 100 | 8,400 | 26 | See observations 15 and 16. |
| 40 | 15.7 | 16.0 | 22.40 | 13.4 | 88 | 7,930 | 27 | |
| 41 | 17.0 | 17.7 | 22.85 | 15.0 | 89 | 7,350 | 28 | |
| 42 | 19.0 | 20.7 | 23.35 | 14.9 | 82 | 6,730 | 29 | |
| 45 | 20.8 | 23.0 | 24.00 | 16.2 | 74 | 5,980 | 30 | |
| 48 | 25.3 | 28.4 | 25.15 | 19.4 | 69 | 4,610 | 31 | |
| 50 | 28.8 | 32.5 | 25.90 | 22.5 | 68 | 3,770 | 32 | |
| 52 | 31.4 | 36.0 | 26.60 | 22.3 | 58 | 3,020 | 33 | |
| 54 | 37.0 | 43.0 | 28.10 | 28.7 | 58 | 1,480 | 34 | |
| 56 | 39.0 | 47.4 | 28.70 | 27.0 | 45 | 900 | 35 | |
| 58 | 40.9 | 49.9 | 29.40 | 28.7 | 44 | 230 | 36 | |
| 17 5 | – | 44.0 | – | – | – | – | – | On ground. |

## A STUDY OF DEPARTURES.

H. GAWTHROP.

THE temperature of the air is recorded daily at the maximum and minimum, and the average of these for the month represents the monthly mean temperature; then again the average of these monthly means, for the period which has elapsed since the opening of a station, is taken as the normal for the month. The oldest stations of the United States Weather Bureau have now been established twenty-two years, and these normals may be considered as close to the seasonal temperature. The difference between the monthly mean and the normal, above or below, has been reported for several years in the *Monthly Weather Review* of the Bureau as the departure from normal.

This statement of the well-known practice of the weather service gives the genesis of the departures, the study of which is the special purpose of this paper. They cannot be considered as the result of diurnal, cyclonic, or seasonal causes, for these influences have been reduced by the process of taking the means. On the contrary, it is claimed that they stand alone as representing phenomena of vast importance, deserving separate and distinct treatment from other phases of temperature.

If the departures from normal temperature at a station are arranged consecutively, month after month, it will be found that they run in courses, alternating warm and cold, and continuing from one to many months.

The tables submitted herewith represent a section from a tabulation of departures as reported in the *Monthly Weather Review*, and are for a period of one year, from July, 1889, to June, 1890, inclusive. Although selected to illustrate a general departure they also show the courses of temperature both at stations and in districts. It may be stated, incidentally, that departures from normal of precipitation follow courses in same manner, though the average duration is somewhat shorter.

In the tables the left-hand column, under each heading, contains the excesses, and the right-hand column the deficiencies for the station or district.

## TEMPERATURE.—DEPARTURES FROM NORMAL.

TABLE I. DISTRICTS ALONG THE NORTHERN BORDER.

| DATE. | N. Pacific Coast Region. | | Northern Slope. | | Upper Miss. Valley. | | Extreme Northwest. | | Upper Lake Region. | | Lower Lake Region. | | New England. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1889. | | | | | | | | | | | | | | |
| July, | +1.8 | - | - | −1.5 | - | −1.5 | - | −1.0 | +0.1 | - | - | −0.5 | - | −1.6 |
| August, | - | −1.2 | - | +1.2 | - | −1.1 | +2.0 | - | +0.9 | - | - | −1.1 | - | −1.0 |
| September, | - | −0.3 | - | −2.0 | - | −2.4 | −1.9 | - | - | −0.4 | - | −1.5 | - | −0.9 |
| October, | +3.3 | - | +4.4 | - | - | −4.0 | +2.4 | - | - | −4.6 | - | −6.3 | - | −3.3 |
| November, | +2.2 | - | −0.9 | - | - | −2.5 | +0.4 | - | +1.5 | - | + 1.2 | - | + 2.3 | - |
| December, | - | −3.3 | +4.9 | - | +14.0 | - | +6.2 | - | +9.4 | - | + 9.4 | - | + 5.5 | - |
| 1890. | | | | | | | | | | | | | | |
| January, | - | −5.5 | - | −5.6 | + 7.3 | - | - | −0.3 | +8.6 | - | +10.5 | - | + 6.2 | - |
| February, | - | −2.7 | - | −3.8 | + 4.6 | - | - | −2.1 | +6.2 | - | + 6.0 | - | + 4.6 | - |
| March, | - | −2.0 | +0.6 | - | - | −4.4 | - | −0.4 | −0.8 | - | − 0.7 | - | + 1.4 | - |
| April, | - | −2.0 | +1.3 | - | - | +1.5 | +4.3 | - | +1.5 | - | + 1.6 | - | + 0.7 | - |
| May. | +1.9 | - | +0.2 | - | - | −4.1 | - | −4.8 | - | −4.6 | - | −3.4 | + 0.2 | - |
| June, | - | −1.6 | −1.0 | - | + 3.7 | - | +2.2 | - | +3.8 | - | + 3.2 | - | - | −1.2 |

TABLE II.—STATIONS NEAR THE FORTY-FIRST PARALLEL.

| DATE. | Red Bluff. | | Salt Lake City. | | Cheyenne | | Omaha. | | Indianapolis. | | Pittsburg. | | New York. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1889. | | | | | | | | | | | | | | |
| July, | +0.2 | - | +2.4 | - | +0.2 | - | - | −1.2 | - | −1.8 | - | −1.4 | - | −0.5 |
| August, | +0.9 | - | +2.4 | - | +2.0 | - | - | −0.0 | - | −1.6 | - | −2.8 | - | −0.5 |
| September, | +3.0 | - | - | −3.4 | −2.0 | - | - | −2.4 | - | −2.5 | - | −2.4 | - | −1.2 |
| October, | −1.6 | - | +3.2 | - | +3.1 | - | - | −1.8 | - | −4.2 | - | −5.0 | - | −5.0 |
| November, | +2.4 | - | +2.0 | - | −3.8 | - | - | −2.7 | - | −0.1 | + 0.5 | - | + 1.9 | - |
| December, | - | −3.2 | +5.6 | - | +8.5 | - | +15.4 | - | +15.7 | - | +11.6 | - | + 7.4 | - |
| 1890. | | | | | | | | | | | | | | |
| January, | - | −6.8 | - | −3.2 | +0.8 | - | + 2.3 | - | +11.4 | - | +11.4 | - | +10.2 | - |
| February, | - | −4.0 | - | +0.7 | +1.2 | - | + 1.2 | - | + 6.8 | - | + 8.0 | - | + 8.4 | - |
| March, | - | −4.2 | - | −1.5 | +1.0 | - | - | −2.4 | - | −2.9 | - | −2.2 | + 1.5 | - |
| April, | +0.3 | - | +0.4 | - | +1.2 | - | + 3.2 | - | - | +1.7 | - | +1.6 | + 0.7 | - |
| May, | +0.8 | - | +3.3 | - | - | −0.3 | - | −2.9 | - | −2.4 | - | −2.0 | + 0.6 | - |
| June, | - | −1.4 | - | −3.2 | - | −1.0 | + 2.4 | - | + 4.7 | - | + 2.5 | - | + 1.4 | - |

TABLE III.—STATIONS ALONG THE GULF AND ACROSS TO THE PACIFIC COAST.

| DATE. | San Diego. | | El Paso. | | San Antonio. | | Galveston. | | New Orleans. | | Pensacola. | | Jacksonville. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1889. | | | | | | | | | | | | | | |
| July, | - | −0.4 | - | −1.0 | - | −2.3 | - | −0.2 | - | −0.4 | - | −1.2 | - | −1.1 |
| August, | +0.8 | - | +1.7 | - | - | −2.3 | - | −2.5 | - | −1.4 | - | −1.8 | - | −2.3 |
| September, | +3.2 | - | - | −1.6 | - | −4.4 | - | −2.5 | - | −0.4 | - | −0.7 | - | +0.1 |
| October, | +3.4 | - | - | +1.0 | - | +0.4 | - | −0.8 | - | −1.6 | - | −3.8 | - | −4.7 |
| November. | +4.0 | - | - | −2.0 | - | −2.2 | - | −2.4 | - | −1.3 | - | −0.4 | +1.9 | - |
| December, | - | −3.6 | +7.2 | - | +13.0 | - | + 9.4 | - | + 9.3 | - | +8.0 | - | +5.0 | - |
| 1890. | | | | | | | | | | | | | | |
| January, | - | −2.0 | +4.3 | - | + 9.4 | - | +12.0 | - | +11.1 | - | +9.8 | - | +7.4 | - |
| February, | +0.3 | - | +1.8 | - | + 3.8 | - | + 5.7 | - | + 5.0 | - | +5.0 | - | +3.8 | - |
| March, | +0.4 | - | +2.8 | - | + 0.6 | - | - | −0.9 | - | −0.4 | - | −1.2 | - | −2.8 |
| April, | - | −0.4 | +0.3 | - | - | −2.1 | - | −0.2 | - | +0.3 | - | +0.4 | - | −0.2 |
| May, | - | −1.6 | +2.2 | - | - | −0.7 | - | −1.0 | - | −0.6 | - | −1.2 | - | −0.6 |
| June, | - | −0.9 | - | −2.4 | - | −3.6 | - | −1.7 | - | −0.4 | - | −0.4 | - | +0.8 |

NOTE.—The prefix of the plus sign indicates the departures above, and the minus sign the departures below, the normal. A departure for a single month, if less than the average of the months immediately preceding and following such departure, is not considered as changing the course. This rule simply extends the mean from monthly to quarterly, and serves to dispose of exceptions, which, though not important, may have served to retard the study of the subject. The signs being prefixed, readers may judge as to how far the rule is warranted.

Attention is first invited to Table III., showing the courses of temperature at stations from Jacksonville along the Gulf coast and across to San Diego. It will be seen that there was unanimity in the departures at most of the stations, sometimes extending to all of them, but yet again varied by independence as shown by San Diego and division of allegiance between the east and west on part of El Paso.

The most marked change in temperature in the period we are considering was between November and December, 1889.

The course had been below the normal at the eastern stations since the spring and then came the change to above the normal for three to six months. This occurred first at Jacksonville, October to November: then a month later, Pensacola to El Paso, five stations between and inclusive, experienced a change from cold to warm averaging more than eleven degrees. This is nearly as much as the seasonal change in that latitude from October to November, so that instead of going forward to December, it was as though the season had gone backward to October.

Before we suspect the sun of halting short of the winter solstice, or think of disputing the claim that sun-spots do not affect the temperature at the earth, we glance at San Diego, less than an hour away from El Paso in the sun's daily journey, and find that the change there was from warm to cold to the extent of 7.6 degrees. The other tables have been selected to illustrate, further, this great departure, the well remembered warm winter of 1889-90.

At the stations along the forty-first parallel, Table II., we find that New York and Pittsburg, like Jacksonville, changed between October and November; Omaha and Indianapolis changing, as at the Gulf points, between November and December. Red Bluff, on the Pacific Coast, changed like San Diego, while Salt Lake City and Cheyenne were variable. The course of temperature at the first four stations named had also been cold for several months, the change to warm being yet more marked than at the Gulf points, and continuing throughout the winter.

Let us now examine the districts along the northern boundary, Table I.: Here the change in New England and the Lake Regions occurred between October and November. And, if we may judge by the extreme Northwest, it is probable that at the

Canadian stations north of these districts, the change came earlier. In the Upper Mississippi Valley the change was between November and December, while on the Northern Slope, between September and October, there was a similar change; but by February that district acknowledged allegiance to the North Pacific Coast Region, which had changed at same time and in same manner as San Diego and Red Bluff.

The variations in temperature incident to cyclones are called waves. May not the phenomena of these departures, in comparison, be likened to the tides, for they dominate all other temperatures?

Glancing over the tables for the country east of the Rocky Mountains, to which we will now confine our thought, is it not evident that the change from cold to warm was the initial movement rather than the change some months later to below the normal? It is found that the changes occur oftener in the spring and summer than in the autumn and winter, but it would seem that in the latter seasons the changes are marked by greater intensity, while the more frequent changes in the former are the termination of the movement. This appears to be the testimony also of other years examined.

The most important inference, however, suggested by the tables is that there seems to have been progress in the change, from north and east towards the southwest. That there is progression in these general departures from the north to the south is the suggestion also of other seasons, not only when the change is to warm but to cold as well.

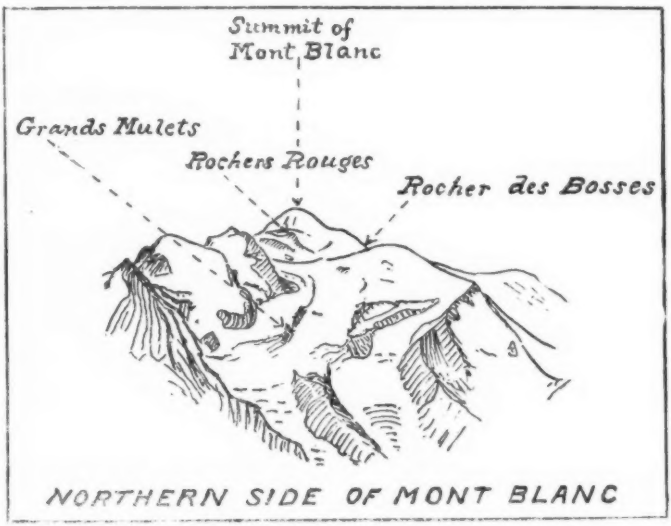
Suppose, then, that the agricultural, mining, manufacturing, and commercial industries, which are affected by the extreme variations of the winters, could have warning, based upon the reports of Canadian stations, that a change, indicating the general character, as to temperature, of the coming winter, had occurred in August or September, which would probably reach the Lake regions by October and extend over the country to the Gulf by November or December; would not such forecast be of incalculable benefit? It is the extreme departure from the normal of which warning is most needed, and observation would indicate that the greater the departure, the more marked is the change from one course to another.

## THE METEOROLOGICAL STATIONS ON MONT BLANC.

A. LAWRENCE ROTCH.

SO much has been written about the observatories on Mont Blanc that there seems to be some misapprehension as to what exists and what is projected. The following was the condition of affairs at the end of August, 1892 : —

The first meteorological station to be built on Mont Blanc, and the only one which actually exists, excepting an auxiliary




NORTHERN SIDE OF MONT BLANC

station at the Grands Mulets, was the Vallot Observatory, at the Rocher des Bosses (altitude about 14,400 feet), which was erected in 1890. A description of this cabin will be found in Vol. VII., No. 9, of this JOURNAL. Since that time the cabin has been tripled in size and otherwise rendered more comfortable, and an independent refuge for guides and tourists has been built this year by M. Vallot.

The observatory is provided with many meteorological and physiological instruments ; but the only instruments which it is attempted to keep in action are a registering thermometer, a

hygrometer and two registering barometers (mercurial and aneroid), all these being of Richard *Frères'* construction, which require to have the register sheets changed and the clocks rewound only once in two weeks. This is done with tolerable regularity by M. Vallot or the guides during the summer; but there are, nevertheless, many breaks in the records, caused by unforeseen stoppages of the instruments. During the winter they are entirely inoperative. At the cabin of the Grands Mulets (altitude about 10,000 feet), erected in 1891 by the French Alpine Club through the efforts of M. Janssen, M. Vallot has placed a self-registering thermometer, hygrometer, and barometer, similar to those at the Rocher des Bosses, from which records were obtained last summer. The meteorological and other observations of M. Vallot during several years past on Mont Blanc are shortly to be published by him in the *Annales de l'Observatoire du Mont Blanc*, in which it is intended to reproduce many of the curves given by the above-mentioned instruments.

As stated in Vol. VIII., No. 7, of the JOURNAL, M. Janssen decided, in 1890, to build an observatory upon the summit of Mont Blanc (15,780 feet), and during the summer of 1891 had a tunnel pierced in the southern flank, just below the crest, to ascertain if a rock foundation could be had. As none was found, a small hut was last year erected on the snow near the eastern slope, and the fact that this hut withstood the winter storms, and was not displaced by the movement of the snow, encouraged M. Janssen to attempt the construction in the same way of an observatory, partly embedded in the snow. It is a significant fact, however, that although the hut was not laterally displaced, yet the snow had been swept away about its base and heaped up on the western side. The roof of the tunnel was also observed to have sunk about eighteen inches. The temperature of the air in the tunnel, at a depth of about thirty feet below the crest, was found last August to be 10° Fahr., while that of the snow in the tunnel was 5° Fahr. The mean annual temperature of the air on the summit of Mont Blanc is probably between these figures.

In order to carry out his project, M. Janssen formed an association, and through the subscriptions of Prince Roland Bona-

parte, M. Bischoffsheim, Baron de Rothschild and others, the sum of $60,000 has been obtained. As a base of operations, a cabin to serve as a refuge for the workmen, etc., is first to be erected at the Rochers Rouges, on the opposite side of the Grand Plateau from the Rocher des Bosses, and about 300 feet higher than the latter. Later it is proposed to build here a more commodious cabin which may serve for astronomical work which is not possible on the summit.

At the end of August the materials for the former cabin had been brought, with much difficulty, up the steep slope of the Mur de la Côte and were ready to be put together. The materials for the summit observatory were still lying below the snow line. They weighed 36,000 pounds, and were divided into 600 loads for porterage.

The summit observatory, which is of timber impregnated with fire-proof paint, was constructed with numbered pieces in Paris, and then was taken apart and sent to Chamounix. In form it is a truncated pyramid, about twenty-five feet high with a base sixteen by thirty-three feet. It is divided into two compartments or stories, the lower story being almost completely sunk in the snow which is calculated to have here a density sufficient to support a weight of 700 or 800 pounds per square foot. There are several rooms in each story for the use, upon the one side, of the director and his staff, and upon the other of tourists and their guides. The two stories communicate with each other by means of a spiral staircase, which also gives access to a rectangular platform twelve by twenty-three feet, and to a smaller platform seven feet higher, upon which will be mounted the various meteorological instruments and possibly an aluminum dome for a telescope. Small stoves burning anthracite coal will be used for heating and cooking purposes, and ventilation will be provided by means of tubes in the lower story, while in the upper story there are windows. There will be no lightning rods since the snow upon which the structure rests is a poor electrical conductor, and no ground is available. The whole structure may be levelled by the use of screw-jacks, should it be thrown out of perpendicular by the movement of the snow about its base.

Such is an outline of this very bold project which may be executed next year. An observer has already been found in

M. Capus, the explorer who accompanied M. Bonvalot in his journey through Central Asia and over the Pamir into India, and it is expected that observations will be made between April and December.

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## STATEMENT OF WORK OF THE NEW ENGLAND WEATHER SERVICE SINCE THE TRANSFER FROM THE NEW ENGLAND METEOROLOGICAL SOCIETY, IN MARCH, 1892.*

J. WARREN SMITH.

ON the transfer of the work and the removal of the office to Boston, I arranged plans for co-operating with the various agricultural bodies in New England, for supporting the publication of the bulletin as follows: The U. S. Weather Bureau has provided paper for printing the monthlies up to July, 1893, and for the 1892 annual, at an expense of $51.57. We have furnished the Maine Board of Agriculture with a monthly table and summary of the Maine weather for their crop reports, for five months, for which they have paid us $20. We have furnished monthly tables and summaries for the Massachusetts Board of Agriculture crop report for six months, and have received from them $60. We are regularly furnishing a monthly summary of the weather for Massachusetts for the bulletin issued by the Hatch Agricultural Experiment Station at Amherst, Mass., and they have paid $25 for this year. The New Hampshire Agricultural Experiment Station has paid in $35, but we have made no arrangement for furnishing them special reports, as suggested and intended. The Massachusetts Board of Health have paid in $45, and in return have been furnished special tables whenever called for. The New England Meteorological Society has paid $50 on subscriptions for the bulletin for their members, and $3 have been received from other subscribers, thus making the total received toward the monthly bulletin, $286.57. I have paid out for paper, printing, and postage, the sum of $276.00, leaving in my hands $10.57, with all expenses

* By permission of the Chief of the Weather Bureau. This paper was read before the New England Meteorological Society, in Boston, October 21, 1892.

paid up to September 1. But I have paid out for maps, cards, etc., $11.82, although this does not properly come out of the fund for supporting the bulletin.

For the balance of the year, the cost will be about $180, and I expect from Maine Board of Agriculture, $30; from the N. H. Experiment Station, at least $65; from the Harvard College Observatory, $50 (this is for the annual summary); from the Massachusetts Board of Health, $15, and from the New England Meteorological Society, $25. If all the agreements are kept, there will be no deficit at the end of the year. The old form of the bulletin has been retained, and two pages of text for questions, correspondence, and personal notes have been added. It is desired to add two pages more as soon as the funds will permit, as they can be easily filled with but little more labor.

The services of about one hundred and sixty-eight crop correspondents, well scattered over New England, were secured at the first of the season, and, up to June 6, a weekly crop bulletin of about two hundred and seventy-five copies was sent out, being printed by the common duplicating process. But, beginning with the following week, arrangements were completed with the Massachusetts Board of Agriculture, whereby the bulletins have been printed, and the number issued increased to over two thousand two hundred. The Board has paid $7 a week for printing these bulletins, or $119 for the season.

As the weekly bulletins took the place of an advance summary, which is issued during the winter months, this was discontinued, and the work through the summer has been as follows: on the 1st, preparing summary of Massachusetts weather for the Experiment Station; 3d, preparing tables and monthly summary for the Massachusetts Board of Agriculture; 4th, tables and summary for the Maine Board of Agriculture; 1st to 15th, preparation of tables and summary for our own monthly bulletin, reading proof and mailing same, and then correspondence and special work for the rest of the month. One day of each week had to be given to preparing the crop bulletin and mailing it. My assistant and myself could not have prepared and mailed this large number in one day without the generous assistance given by the local forecast official in charge of the Boston office and by the Board of Agriculture; but, with this assistance, we were enabled to mail all the bulletins on the day of issue. Special

reports of the temperature and precipitation were received weekly from about thirty-five observers over New England, and a chart showing the amount of rainfall and mean temperature was prepared on this day, also, for publication in connection with the weekly crop bulletin in the *New England Homestead*, at Springfield, Mass.

The work of attending agricultural meetings had been begun before the transfer, and was continued through the spring. During January, lectures on the work of the Weather Bureau, and the advantages to be derived from their forecasts and various publications, were delivered by myself at Newport, N. H., Marshfield and Southbridge, Mass.; in February, at New Milford, Collinsville, Windsor, and East Hartford, Conn.; March, at the Horticultural Hall, in Boston; April, at Bowdoinham and Clinton, Maine; and in July, at Hemlock, Mass. A part of the expenses for these trips have been met by the Weather Bureau, but mostly by the Boards of Agriculture. We find at these meetings, which are mainly in the agricultural sections, a growing interest in the work of the bureau, and a general desire to learn its methods and plans. In several places, the high schools were closed, and the school attended the lecture in a body. This is a work that I believe should be taken up to a much greater extent.

Of the voluntary observer stations, some half dozen have been discontinued, though none because of the transfer. The observer at Cotuit, Mass., has recently written that he will not be able to continue observations, and promises to place his instruments in the hands of a reliable person there. Northampton has also been discontinued, and the instruments are at the disposal of a good observer. An attempt is being made to secure observers in both places, but without success thus far. New stations have been established as follows: In Maine, the Weather Bureau has furnished instruments for three, and will supply them for one more as soon as an observer can be secured — it is much desired to place this station in the Rangeley Lake region; the Harvard College Observatory has furnished instruments for two stations, and one old station, Gardiner, is to be reestablished. In New Hampshire, the Weather Bureau has fitted up one station; the Observatory one, and the Appalachian Mountain Club two and will fit up another at Bethlehem as

soon as an observer can be secured there. In Vermont the Weather Bureau has fitted up two stations, and two have been opened with private instruments. Jacksonville is soon to be re-opened also. In Massachusetts, the Observatory has fitted up one station, eight have been opened with private instruments, and one is to be established by the Board of Agriculture at Great Barrington, as soon as the instruments are received. In Connecticut, one station has been fitted up by the Observatory, and Middletown has been re-established with Mr. Ward's old instruments; the Storrs Agricultural School has purchased four rain-gauges and placed them in towns surrounding Mansfield, but we have been able to secure but one to report to us as yet. In New York, the old station at Lebanon Springs has been re-established. Thus the efforts to establish stations in the uncovered sections in the northern States and in western Massachusetts have not been without success.

On June 30, 1891, the daily weather forecasts were being telegraphed at government expense to twenty-two places in New England. On October 1, 1892, they were being sent at government expense to ninety places and by free service to forty-four others where flags are being displayed or whistles blown. From these centres the information goes by free telephone, telegraph, or mail into many surrounding towns and villages. In addition to the above, the warnings of impending frosts are sent to about seventy-five places at government expense. Arrangements were made in September for giving the daily forecasts by means of the flash light recently placed on Mount Washington, and it is intended to continue this experiment, if it may be so called, during the coming season. Cards and circulars giving the key to the signals are already printed and will be distributed in the spring to post-offices and hotels over a large district surrounding the mountain. During the short time this fall when it was in operation a gentleman wrote this office that he had read the signals with ease at a distance of over one hundred miles. The daily forecasts are being sent by the Southern New England Telephone Company from New Haven to thirty-four exchanges in Connecticut and Massachusetts free of charge, and from there given to any one who asks for them; and they are also being carried by train service from New Haven to 184 stations, from Portland, Me., to 87, and from

Boston to 380. The Bureau furnishes a neat frame which is hung in the depots, and the station agent posts the forecasts as they are received over the trains. No credit should be given the New England Weather Service, however, for this railroad work or that being done by the Southern New England Telephone Company, but rather to the observers at New Haven, Boston, and Portland.

To show the amount of work necessary to accomplish the above, will say that, for the four months ending with September, we sent out 294 bundles of supplies to voluntary observers and crop correspondents; over 1100 personal letters; over 1200 circular letters and over 35,000 monthly and weekly bulletins.

In considering the plans for the future, we note the following lines of work: 1st, continuing the collection of records taken by the voluntary observers and publishing the same in a concise and interesting manner; 2d, the extension of the daily weather forecasts into the agricultural districts, and the establishment of a frost warning system over the tobacco and cranberry growing sections, and 3d, the more general collection and distribution of the crop conditions and the effect of the weather upon them during the crop season. And to take these up and carry them on to their fullest perfection will require the closest co-operation between the Weather Bureau and the people — the former represented by the New England Weather Service, and the latter by the various boards of agriculture, the grange, the experiment stations, etc.

The value of the tabulated temperature and precipitation records, for studying the relation of the climate and crops and the climate and health, is unquestionable. Its complete proof is the great attention paid to this branch of meteorology by nearly every people. The New England Meteorological Society has already done a great work in organizing one of the most complete voluntary observer systems in the United States; and by the co-operation of the Harvard College Observatory has published the records in a compact form, and the New England Weather Service should be enabled to continue this publication by the assistance of the agricultural experiment stations in New England. The cost of the bulletin in its present form is about $40 per month, or in the neighborhood of $500 for the year with the annual summary. The sum of $75 a month from each of

the stations together with the subscriptions now received will pay for printing the bulletin, or $85 from each will pay for printing the bulletins and enable us to send them to any one who would be benefited by or interested in them, free of charge. In return for this sum we suggest that we send a monthly summary for publication in somewhat the same manner as is now sent to the Massachusetts station, and for which they have guaranteed the sum of $50 or more for next year; or, if preferred, a certain number of the bulletins can be sent each station for distribution. We suggested to the New Hampshire station that they print a quarterly publication, part to be made up from the meteorological records at this office, and part from their station records. However, we feel that the experiment stations will be fully justified by the terms of their establishment to appropriate the above sum for the proper preservation of these meteorological records.

The continued calls for the daily forecast service show their value among those engaged in agricultural pursuits. The Bureau is disposed to grant as many of the requests as possible with its appropriation for telegraphic service, but its limit is soon reached, and so every effort is made to extend the free service by telephone and train service. But when the forecast is printed and posted in the depots there still remains something more to be done. In many cases they may hang there for days almost without being of any benefit to those most interested. In the busy season of planting or harvesting the farmer has no time to drive several miles to see what the forecast is. But some method must be urged for displaying the forecasts by flags or giving them by whistles. I believe that the *Grange* can give the most assistance in this, and that through the action of the local granges these forecasts can be taken at the depots where they have been sent without expense to this bureau beyond that of preparing them, and given to the surrounding people. The train service is good as far as it goes, but it must be supplemented by something more. The master of the State Grange in Connecticut, especially, is not only "talking" this feature of the weather work among the granges of the State, but is showing by his example that the forecasts and warnings are of value. He is sustaining a station at Woodstock at his own expense, both for flags and for arrange-

ments to receive the messages from the distant telephone exchange.

The collection and distribution of reliable crop information, and the effect which the weather is having upon crops, is considered by the Weather Bureau to be one of the most important branches of its work. As has been stated above, this service collected information from about one hundred and fifty different districts of New England last year, and, through the Massachusetts Board of Agriculture, were enabled to make a wide distribution of the results, in a neatly printed bulletin. The Boston *Journal* pronounced the last general summary for the season, which was given in the last bulletin, the most complete of its kind ever issued. The Massachusetts Board of Agriculture proposes to assist in the publication next season, and to make even a wider distribution than last year, and we shall urge other boards to aid in the matter. We shall make a special effort to have every district well represented, and shall issue the bulletins promptly and regularly. Arrangements can be made with a printer in this city whereby five thousand copies can be printed and mailed on the day of issue, and at a cost of about $20 a week, or for $4 per thousand for the different boards.

For the proper discussion of the above plans, I will suggest that the New England Meteorological Society and the New England Association of Applied Meteorology hold a joint meeting next January, and to that meeting invite the voluntary observers, displaymen, and others interested in the extension of the benefits to be derived from the weather service in New England. The New England Meteorological Society represents the pioneers in voluntary weather service in New England, and the leaders in scientific investigations of meteorological problems in this country outside of the National Weather Service; the New England Association of Applied Meteorology is composed of officials of the various boards and organizations actively interested in the practical application of the facts already deducted, and the voluntary observers, displaymen, and crop correspondents represent the source from which much of the information is obtained, and the medium through which the results of the investigations are given to the public. The result of a union meeting and discussion of the plans for the future of the work should, therefore, be productive of much good. I recom-

mend, then, that steps be taken toward a union meeting at the time of the society's regular January meeting, and that the secretaries of the two organizations be asked to draw up a program, allowing for ten minute papers and five minute discussions upon the most important problems which now face us.

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## ANEMOMETER COMPARISONS.*

S. P. FERGUSSON.

THE most noteworthy of recent tests of anemometers are those which were made in England by Mr. Dines of the Royal Meteorological Society, and in America by Prof. Marvin of the U. S. Weather Bureau. The results of these independent experiments, while agreeing in showing that the Robinson cup anemometer registers too high, differed as to the amount of the error, Mr. Dines finding that of the Kew Observatory pattern practically constant, while Prof. Marvin found the error of the U. S. Weather Bureau instrument variable.

Rough comparisons of a Richard fan anemometer (anemocinemographe) and a Weather Bureau cup anemometer at Blue Hill in 1891 and the present year seemed to indicate that the actual error of the cup instrument was more nearly constant than that determined by Prof. Marvin, as the two instruments agree closely at all velocities, and being of entirely different construction could hardly be subject to the same errors.

So far as known direct comparisons of the English and American standards have never been made, and the importance of such a comparison being apparent, a series of tests was begun at Blue Hill Observatory, in order to determine as far as possible the differences between these and other forms of anemometers, as well as the pattern best adapted to general use. This work was begun in August, 1892, and is to be continued during the present winter; the object of this article being to give an account of the experiments to date and indicate the methods to be followed.

The conditions for direct comparisons at this observatory are

* Read before the New England Meteorological Society in Boston, October 21, 1892.

probably the best that could be obtained, as the exposure is free on all sides and the range of wind velocity exceptional. Velocities of fifty miles an hour or higher are of frequent occurrence during the winter months, hence comparisons at high as well as low velocities can be easily made.

The instruments compared up to the present time are a Dines helicoid air meter and two Robinson anemometers of the Weather Bureau type, one with brass and the other with aluminum cups, the last named having been kindly loaned by the Weather Bureau for use in these experiments.

The helicoid instrument differs from all other anemometers in having a single blade of aluminum very light and shaped like a screw propeller, for the wind to act upon, its revolutions being indicated by dials. As this individual instrument had been carefully tested upon a whirling machine by independent observers, it was used as a standard for comparison, the error being constant and less than one per cent.

The Weather Bureau type of anemometer is too well known to require further description than that the cups are four inches in diameter and are mounted on arms 6.72 inches long. The weight of the brass cups is sixteen and that of the aluminum cups nine ounces. Neither of the two instruments used had been compared with a standard so far as known.

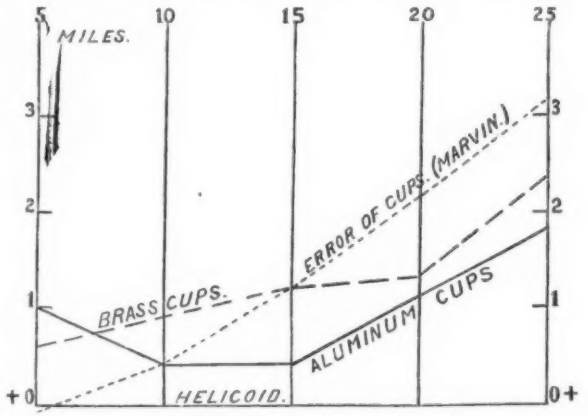
The instruments were exposed on a pole twenty-five feet higher than the roof of the observatory, so as to avoid all eddies produced by the building, a cross arm carrying two anemometers being secured to the top of this pole.

The helicoid and the aluminum cup anemometers were compared first, and afterwards the two cup anemometers were compared, to determine the differences between them. For the cup anemometers a "Gibbon" recording apparatus was used, each mile of wind movement being registered electrically on paper moving two inches an hour, while for the helicoid a recording apparatus of special construction was used, the time scale of which could be altered from two to twelve inches an hour, as desired. In practice it was found that each 1000 feet of wind could be recorded upon the paper when it moved six inches an hour, and, accordingly this rate was adopted, a convenient contact maker having been attached to the helicoid by Prof. Marvin.

The absence of very low velocities of an hour or longer dura-

tion rendered tests of the sensitiveness of the instruments somewhat uncertain, especially in case of the helicoid which is affected by the variable direction usual at low velocities. From the few observations made, it appeared that the aluminum cup anemometer was the first to move when the wind velocity increased from near zero, and probably requires a velocity of between one and two miles an hour to keep it in motion, the other instruments requiring a slightly higher velocity to move them. The vane carrying the helicoid has first to be acted upon by the wind before the fan is set in motion, and, on this account, the instrument tends to under register at low velocities when the direction of the wind is variable.

The helicoid was found to adapt itself to variations in velocity more readily than the cup anemometers, the least sensitive in this respect being the brass cups, which gave higher velocities during variable winds. The sensitiveness of the instruments was determined by observations of the cups and fan, during low and variable velocities, and by noting their action as compared with the movement of light substances floating in the air.




The accompanying diagram shows the differences of the brass and aluminum cup anemometers from the helicoid at velocities under twenty-five miles an hour, each curve being determined from about ten observations at each velocity. The curve of error of the Weather Bureau anemometer, determined by Prof. Marvin, is also given for comparison.

The most important points developed by this comparison are:—

(1.) The Weather Bureau instrument registers higher than the helicoid, and the differences apparently increase with the velocity.

(2.) When the record of the Weather Bureau instrument is corrected by Prof. Marvin's table, it is considerably lower than that of the helicoid at all except low velocities, notwithstanding the fact that the helicoid probably gives velocities slightly too low, on account of the sluggishness of the vane carrying it.

(3.) The brass cups apparently register higher than the aluminum cups, except at velocities below five miles an hour.

There were some irregularities in the differences between the anemometers that may disappear when the results from a larger number of comparisons are used, as the curve from a smaller number of observations was found to be still more irregular. There were other differences, however, between the cup anemometers which lacked explanation, some of which could not be due to differences between the cups.

The following are the differences between the two cup neamometers, the cups being exchanged from one instrument to the other during the second comparison. The figures indicate the excess of the brass cups.

| Velocity | | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|---|---|---|---|---|---|---|---|
| Difference | 1 | −0.7 | +0.5 | +0.9 | +0.3 | +0.8 | +1.3 | +1.4 | +1.5 |
| | 2 | −0.2 | +0.5 | +0.8 | +0.1 | 0.0 | 0.0 | - | - |
| Mean | | −0.4 | +0.5 | +0.8 | +0.2 | +0.4 | +0.7 | - | - |

The anemometer carrying the brass cups during the first series moved with slightly more friction than that used in the second series, but the difference between the two was so slight that it does not seem sufficient to account for the increase of error of the brass cups in the first series and the marked decrease in the second, especially as the greatest difference occurred at the highest velocities observed during the experiments and where the friction would most likely be inappreciable. It may be, however, that the friction varies in the two instruments independently of the velocity, as there are some slight mechanical differences between them, but the difference due to friction, even at low velocities, was not very accurately determined, and further tests are necessary in order to decide this question.

Further comparisons of these instruments are to be made during the present winter at all velocities, and also additional instruments have been selected for comparison, among which are a Kew pattern cup anemometer with nine-inch cups mounted on twenty-four inch arms, now being constructed at the observatory-a self-adjusting helicoid anemometer, a Richard anemo-cinimographe, and a pressure plate. A large recording apparatus capable of receiving the indications of four instruments at once has been built, and the anemometers requiring such adjustment are being altered so that each will record tenths of miles, thus making the comparison of a number at once quite easy. It is believed that these relative comparisons will be of value not only in determining the differences between the standards of the different countries, but in determining with some degree of accuracy the actual error of each, as it is proposed to use at least two instruments whose individual errors have been accurately determined.

# CURRENT NOTES.

*Weather Bureau Notes.*— Prof. Mark W. Harrington, the Chief of the Weather Bureau, has been to the City of Mexico as representative of the Bureau at the annual meeting of the American Health Association. Several papers on the relations of weather services to sanitary science, and the directions in which the meteorologist can best be of service to the physician were read by Prof. Harrington before the Association.

The scientific staff of the Weather Bureau has been greatly strengthened by the appointment, on September 10, of Dr. Carl Barus to the position of professor of meteorology. Dr. Barus has won an enviable reputation in the field of physical science by his original researches, the results of which have appeared mostly in the *Annalen der Physik und Chemie*, the *American Journal of Science*, the *Philosophical Magazine*, and the Bulletins of the U. S. Geological Survey. He was born in Cincinnati, Feb. 19, 1856, where he received his early education. The period from 1874 to 1876 he spent at Columbia College, New York, and that from 1876 to 1880 at the University of Wurzburg, Germany. From 1880 to the time of his appointment in the Weather Bureau he held the position of physicist to the U. S. Geological Survey. In 1890 he was elected a fellow of the American Academy of Arts and Sciences, and in 1892 became a member of the National Academy of Science.

The Weather Bureau has recently issued a card, about eight by six inches in size, giving side by side the Fahrenheit and Centigrade scales. It shows at a glance temperatures on either scale and their corresponding values on the other. It also calls attention to the fact that the Centigrade and Celsius scales are not (as generally given in text-books) identical. The Bureau will furnish one of these cards to anyone asking for one. A. M.

*Hot Winds.*— In an article in the *Monthly Weather Review* of August, descriptive of the warm waves of July and August, 1892, reference was made to distinctive differences between the warm waves and hot winds of the United States. A consideration of the Foehn and desert types of winds of the leeward slopes of the western mountain ranges was intentionally avoided. These types are peculiar to localities and differ materially in origin and character from the hot or drought winds of the central valleys and eastern States. The Foehn-like winds which are products of conditions which at times obtain on the eastern Rocky Mountain slope are receiving practical and intelligent investigation at the hands of at least one Weather Bureau official. This official is making, on the ground, a special study of the hot winds of Texas. A peculiar characteristic of this type is that they are

destructive to vegetation not only during periods of drought but also when the soil is charged with moisture. Another remarkable feature is that vegetation is scorched in strips leaving intermediate bands uninjured. The problem to be solved in this direction is to determine whether the hot air is drawn from the "staked plains," or whether air is heated dynamically in descending the eastern Rocky Mountain slope. In any event the hot, dry wind descends upon a moist region and seemingly forces its way to the ground through the less dense parts of the moist air mass that immediately overlies the earth's surface. A publication of results of intelligent investigation conducted in an endeavor to determine the cause of these winds will doubtless be a valuable contribution to meteorological literature.

E. B. G.

*Recent Artificial Rainfall Experiments.*—Some preliminary experiments by the party charged with the responsibility of bringing down rain by artificial means were made at Fort Meyer, a U. S. military post near Washington, on Nov. 3. Under the direction of Gen. Dyrenforth a series of explosions was made by Mr. J. T. Ellis, to determine the effect of certain new explosives, especially rosellite, upon cumulus or nimbus clouds passing overhead. The explosions took place early on the morning of Nov. 3, between 1 and 4 A. M., and brought forth such a vigorous protest from physicians and citizens of Washington, whose slumbers were disturbed by the terrific noise, that the experiments were cut short and the expedition left for Texas, where further experiments will be carried on. While the main object of Gen. Dyrenforth, in these preliminary experiments, was to test certain explosives which are to be used in Texas, the light rains which fell during the night are claimed as the result of the explosions. According to the records of an observer in the city, about three miles from the point of disturbance, "a lively shower of rain followed the explosion at 1.50 A. M. At 2.41 another explosion occurred, and rain followed within two minutes; but the clouds broke away and the sky cleared. At 3.06 rain followed the explosion within eight minutes. No rain occurred after the explosion at 3.44."

Mr. Ellis states that explosions were commenced at 1.30 A. M. and continued at intervals of eight and fifteen minutes until 3.45 A. M., with the following results: "1.30. Rain in large drops in five seconds, continuing about four minutes; 2. Rain within a minute, continuing about two minutes; 3. Rain in about ten seconds; 4. Rain in about two minutes, at first very slight, but increasing and continuing up to the firing of the fifth charge; 5. Rain continues but does not increase; the clouds are becoming attenuated; rain ceases in about two minutes; 6. Very light charge, no rain; 7. Usual charge of from 20 to 40 pounds; slight rain in about four minutes; 8. Atmosphere is getting clearer overhead; no rain; 9. Slight rain in about three minutes; 10. Very slight rain in about five minutes; 11. No rain; atmosphere now clear overhead; 12. This charge is fired after about 30 minutes' delay, to allow a cumulus cloud to pass overhead; this cumulus becomes very much attenuated as it travels, and when overhead is quite insignificant; no rain."

The U. S. weather maps for 8 A. M. and 8 P. M. of the 2d show Washington to be on the edge of a vast rain area, extending all the way from Maine to the Gulf, and slowly advancing eastward, while a trace of rain was recorded at 8 A. M. and 8 P. M. of the 2d, and at 8 A. M. of the 3d. The official forecast at 8 A. M. of the 2d for the District of Columbia was "showers," and at 8 P. M., "light showers."

In Texas the experiments will probably be continued in the neighborhood of San Antonio, where a sum of $6,000 has been contributed by citizens for this purpose.

*Aurora During Moonlight.*—Mr. Alexander McAdie, of the Weather Bureau at Washington, reports that an aurora was observed in Washington between 7.40 and 8.10 P. M. on Nov. 4. There was a full moon, and a few globo-cumulus clouds were noted in the sky. Deep crimson streamers were seen in the northeast, which looked like an illumination with Bengal fire. The northwestern portion of the aurora developed about ten minutes after the maximum intensity in the northeast. It is rare to have in this latitude an aurora strong enough to be seen during moonlight.

# BIBLIOGRAPHICAL NOTES.

## LIGHTNING CONDUCTORS.

OLIVER J. LODGE, F. R. S. "*Lightning Conductors and Lightning Guards.*" The Specialists' Series. Macmillan, 1892. 544 pages. $4.00.

Dr. Lodge says in his preface that this book is the outcome of a couple of lectures which he was asked to deliver in 1888 before the Society of Arts in memory of the late Dr. Robert Mann, an enthusiastic advocate of lightning-rods. Some experiments made by Dr. Lodge in preparation for these lectures led him to believe that several of the current ideas on the subject were unfounded and incorrect; mainly because the momentum of an electric current and the energy of an electrostatic charge had both been more or less overlooked. "The application of the known fact of electrokinetic momentum revolutionized the treatment of certain phenomena. The old drain pipe idea of conveying electricity gently from cloud to earth was thus proved fallacious, and the problem of protection became at the same time more complex and more interesting." He then alludes to the idea that got abroad (and we think that quite a number of good-intentioned but not deep readers have the notion that a high scientific authority has recently passed the word that lightning-rods must go) that his experiments proved that lightning conductors, as now erected, were useless if not positively dangerous. *This is not so.* Lodge's position is simply that while any conductor probably does a certain amount of protecting, few or none of the present types are *absolute* and *complete* safeguards. (And he believes it to be within the possibilities to so modify existing protective systems as to afford more certain protection.) The case as it stands may be summed up as follows: Dr. Lodge has clearly and brilliantly shown that the problem "What happens when a certain flash of lightning passes along a certain conductor?" in the light of recent discoveries of electrical inertia, self-induction; the oscillatory character of the flash; the impedance for frequencies as high as a million per second, — is a problem very far removed from the old easy one of ordinary slow conduction. Thus far, Lodge is decidedly in the right, and the work he has done in following up these truths and in directing attention to the necessity of considering the matter from his standpoint, entitles him to be ranked among public benefactors. A physicist having the courage of his convictions, he has held it to be his duty to attack the report of the lightning-rod conference. It came with a shock indeed, just when we thought we had succeeded, after many years of dispute, in settling the question whether rods did protect or not, to have the established order so scientifically and spiritedly assailed. The famous discussion at the British Association meeting of 1888 ensued. The honors seem to be about evenly divided; for while Lodge has undoubtedly the clearer insight into the character of the flash,

the decisions of the conference regarding the value of good present methods stand, and we fancy, inasmuch as they are based upon experience, will stand for some time to come. In the particular matter of the form of conductor, we follow Lodge and prefer the tape to the solid rod. This takes us back to the time of Faraday and Snow Harris. The latter experimented some, but, after all, his best information came from extensive study of the effects of actual flashes. In this, in the long run, he proved himself wiser than Faraday. For Faraday, in 1850, seeing only the question of conductivity in the problem, said decidedly "surface did nothing; the solid section was the essential consideration." The conference, too, inclined to this belief. To-day, we know from the experiments of Hertz, Lodge, and others, that when an electric current flows steadily in one direction in a conductor, its intensity is the same in all parts of the wire; but if it be of an oscillatory character, *i. e.*, a current reversing rapidly in direction, the interior of the conductor may carry far less than the surface carries. This proves then the correctness of Harris's position that surface had rather more to do with the question than solid section. The story has been told before in these columns,[1] but will bear repetition. A British admiral had occasion to approve plans for a lightning-rod on a certain light-house. He thought the surface theory of Harris was correct; but thought he would consult Faraday. He did so and was told that the conducting power depended entirely upon the volume of copper in the section of the conductor, and it made no difference whether it was in the form of plates, rod, or tube. And if Harris said otherwise "then he knows nothing about it." A few days later he saw Harris and inquired about the best form of rod. Of course the answer was in favor of surface conductors and he added "if Faraday says otherwise, then he knows nothing about it." We believe to-day with Harris. Increase of surface diminishes impedance; and as impedance is probably at the bottom of side-flashes and spittings, that conductor is to be preferred which offers least impedance, and hence tape is better than rod. It is also more convenient; but it is to be noted that the tape must be of dimensions sufficient to withstand melting or deflagrating. As Sir William Thomson said during the discussion, "while we admit the validity of some or perhaps all of Lodge's criticisms and admire the vigor of his attack, there is a very comfortable degree of security in the conductors made according to the conclusions of the conference."

It is our business to point out that Lodge does not argue against the need of good earths, but does insist that a good earth is not the whole problem. It is also necessary to emphasize the fact that multiple flashes are not to be confounded with the oscillations of current. With the former we are dealing with intervals of time about one-fiftieth second duration, and a revolving mirror or sensitive plate will resolve and analyze these into their constituent flashes. The oscillations are something like three million per second.

We wish all readers of the JOURNAL might have a copy of this book. For meteorologists there is a delightfully interesting field of work mapped

[1] Vol. ix., June, 1892, page 87.

out in Chapter XIV., and now is the time in which to do it. We are every day finding out more about currents of high potentials and great frequencies of alternation. The very recent experiments of Elihu Thomson and Tesla are the forerunners of experimentation upon actual flashes of lightning.

The typographical make-up of the book is perhaps as good as the selling price will allow. We wish though that it had been a little more elaborate, It bears the impress of "hurried" work. Dr. Lodge's grace of style is less noticeable in this volume than in his "Modern Views of Electricity." The picturesque analogies are lacking and he is a trifle too positive in statement. But it speaks of work, earnest, scientific work of high order, and one cannot read the book and put it down without a feeling of personal interest in Dr. Lodge and a desire to serve under him. He says somewhat mournfully in the Preface that the lightning photographs "have lost terribly in reproduction." There is truth in the statement.

ALEXANDER MCADIE.

U. S. WEATHER BUREAU, Nov. 1892.

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## MORTALITY UNDER DIFFERENT CONDITIONS OF TEMPERATURE AT GALVESTON, TEXAS.

UNDER the above heading, in the monthly bulletins of the Texas Weather Service, from November, 1890, to July, 1891, is to be found a number of interesting tables compiled by Dr. Cline. In the first table is given a detailed summary of the temperature changes and conditions for fifteen years. The twenty-four hour change in the minimum temperature was used for determining the daily temperature change. In the first column is given the falls of 4° to 9°; in the next, the rises of 4° to 9°; in the next, the falls of 10° or more; in the next, the rises of 10° or more; in the next, the number of days of abnormally high, and in the next, the number of days of abnormally low temperature. Under abnormally high or low temperature were included the days whose mean departed 8° or more from the normal, and also periods of four or more days whose daily means departed 5° or more.

The following table shows the percentage of frequency in days found for each of these changes: —

| | Jan. | Feb. | Mar. | Apr. | May | June | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Falls of 4° to 9°, | 20 | 15 | 12 | 12 | 11 | 6 | 5 | 10 | 10 | 14 | 18 | 18 |
| Rises of 4° to 9°, | 22 | 24 | 22 | 14 | 12 | 6 | 6 | 8 | 10 | 15 | 20 | 24 |
| Falls of 10° or more, | 7 | 8 | 7 | 4 | 2 | 1 | 1 | 1 | 2 | 4 | 10 | 10 |
| Rises of 10° or more, | 8 | 5 | 4 | 2 | 2 | 1 | 0 | 0 | 1 | 1 | 5 | 6 |
| Abnormally high, | 21 | 18 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | 5 | 20 | 24 |
| Abnormally low, | 25 | 16 | 12 | 7 | 2 | 0 | 0 | 0 | 6 | 13 | 20 | 18 |

These show a well-marked annual period with the greatest frequency of changes and abnormal departures in January and least in July. In July, the temperature changes from day to day less than 4° on 88% of the days, and in January on 43% of the days. This shows that continuous predictions of "stationary temperature" in summer would reach a very high degree of success. But one of the most interesting features shown by this table is that almost entirely throughout the year the number of rises of 4° to 9° is greater than the number of falls of 4° to 9°; while the number of falls of 10° or more is greater than the rises of the same amount. Since, on the average, the amount of rise must equal the amount of fall, the above merely means that the falls are more rapid than the rises, and frequently exceed 10° or more in twenty-four hours. This agrees very well with what has been found elsewhere. Köppen found that in Karabagh the mean daily rise in temperature was 1.43° C., and the mean fall 1.63° C., thus proving that rises of temperature are more frequent and less sudden than falls. In Hann's extended study of temperature changes at many stations in Europe, Asia, and America, published in the *Sitzungsberichte der Wissenschaften*, Vienna, 1875, he shows that this is true for almost the entire world. Blandford has confirmed this for India, where he says: "Rapid falls of temperature are between two and three times as frequent as rises" (*Climate and Weather of India*, page 12). Scott has shown, however, that in the British Isles rises of 5° or more, as well as rises of 10° or more are more frequent than falls of the same amounts, and hence this region is probably an exception to the general rule. (*Proceedings of the Royal Society*, London, 1890.)

More tables of this kind would be interesting in our own country. In the subsequent tables, Dr. Cline gives the number of deaths which accompany each temperature condition examined. In the accompanying table are given for the year the percentages of days with each temperature condition and the percentages of deaths from different diseases on those days.

TEMPERATURE.

| | Changes. | | | | | Departures. | | |
|---|---|---|---|---|---|---|---|---|
| | 0° to 4° | Falls. 4° to 9°. | Rises. 4° to 9° | Falls. 10° or more. | Rises. 10° or more. | Normal. | High. | Low. |
| Percentage of days with, | 65 | 13 | 15 | 4 | 3 | 82 | 8 | 10 |
| Percentage of total deaths, | 65 | 12 | 16 | 4 | 3 | 80 | 9 | 11 |
| Respiratory diseases, | 61 | 13 | 17 | 5 | 4 | 75 | 11 | 14 |
| Circulatory diseases, | 62 | 14 | 15 | 5 | 4 | 80 | 9 | 11 |
| Blood diseases, | 68 | 12 | 14 | 5 | 1 | 81 | 11 | 8 |
| Digestive diseases, | 67 | 11 | 15 | 4 | 3 | 86 | 7 | 7 |
| Genito-Urinary diseases, | 66 | 15 | 14 | 7 | 2 | 84 | 2 | 14 |
| Nervous diseases, | 65 | 11 | 17 | 4 | 3 | 83 | 8 | 9 |
| Fevers, | 66 | 12 | 15 | 4 | 3 | 80 | 9 | 11 |
| Remainder, | 66 | 12 | 15 | 4 | 3 | 82 | 9 | 9 |

Considering the many causes controlling the death rate, and the fact that most of the diseases have a more or less pronounced annual period, the

agreement of the frequency of deaths with the frequency of days seems wonderful; and the writer thinks proves conclusively that neither the sudden temperature changes nor the brief departures from the normal produce any immediate sensible increase of deaths from any diseases over the normal rate, though Dr. Cline himself reaches a different conclusion.

The small discrepancies in almost every case can be explained by the annual period in the disease. For instance deaths from respiratory diseases appear in the table to be somewhat larger on days of greater temperature changes and departures than the number of days; but this is evidently due to the fact that the death rate from lung troubles is greatest in winter when the precentage of days with such temperatures is greater than the average for the year. Taking the separate months the distribution of deaths agrees closely with the distribution of days of temperature changes and departures; or in other words the death rate is sensibly the same under all the temperature conditions examined and is not apparently influenced by them.

H. H. C.

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## THE WINDS AND DISEASE.

"THE Geographical Distribution of Disease in Great Britain," Dr. Alfred Haviland (London, Sonenschein, 1892). This is the extended second edition of a work first published in 1875. The author maintains that cancer is more fatal to women in clayey flooded areas than on elevated, calcareous soils; that heart disease and rheumatism are more fatal in the unventilated valley system of England and Wales than in the open areas freely exposed to the prevailing winds and sunshine; and that those tainted with phthisis succumbed readily to the full blast of prevailing winds. These statements are based upon an extended analysis of the death returns from 1850 to 1870 and 1880 on the one hand, and a review of the physical features of England on the other. The volume in hand deals chiefly with the English Lake district; another is promised on the Valley of the Thames.

Dr. Haviland's conclusions appear to be insufficiently based in two respects: first, in accepting data concerning diseases from geographical districts not closely coincident with physical or geological districts; second, in failing to consider the possible action of causes that may vary nearly enough with the English winds or soils and yet really be independent of them. For example: regarding phthisis, our western elevated plains have, according to Waldo (AMERICAN METEOROLOGICAL JOURNAL, vi., 260), a higher mean wind velocity than the New England States; yet they are recommended for consumptives who not infrequently recover their health in the dry atmosphere east of the Rockies. Dampness, rather than windiness, here seems to be the real difficulty; and if so, a physician would be misled in following Dr. Haviland's conclusion; he might prescribe a quiet district and yet err in sending his patient to a district of high humidity. The important element of humidity is not examined by Dr. Haviland, and yet it must vary greatly with the wind force on an island to leeward of an ocean.

W. M. D.

## TITLES OF RECENT PUBLICATIONS.

AITKEN, JOHN. *On the number of dust particles in the atmosphere of certain places in Great Britain and on the Continent, with remarks on the relation between the amount of dust and meteorological phenomena.* Part ii. From the Tr. Roy. Soc., Edinb., vol. xxxvi. (1892), pp. 17-49, 1 pl.

ANDRÉ, CH. *Relations des phénomènes météorologiques deduites de leurs variations diurnes et annuelles.* 8vo. Lyon, 1892. 168 pp.

BINNIE, A. R. *On mean or average annual rainfall and fluctuations to which it is subject, with an abstract of the discussion upon the paper.* (Excerpt Pr. Inst. Civil Eng., vol. cix.) 8vo. Lond., 1892, 92 pp., tables and diagrams.

CLARK, J. EDMUND. *Fifty years of York meteorology.* 1841–1890. (Reprinted from the Rep. of the Yorkshire Phil. Soc., 1891, pp. 43–64, 11 pl.)

COIMBRA. *Observacoes meteorologicas e magneticas feitas no Observatorio Meteorologico e Magnetico da Universidade de Coimbra no anno de* 1891. Fol. Coimbra, 1892. 153 pp.

GANYMEDE. (*Pseud.*) *Problems in physics and their application to dynamic meteorology.* 8vo. n. p., 1892, 48 pp.

GENOVA. REGIA UNIVERSITÁ. *Observatorio Meteorologico. Stato meteorologico e magnetico di Genova per l'anno* 1891. Annolix. Fol. Genova, 1892. 33 pp.

INDIAN METEOROLOGICAL MEMOIRS. Vol. v. pt. i. *The diurnal variation of atmospheric conditions in India; being a discussion of the hourly observations recorded at twenty-five stations since* 1873. *No. 1, containing the discussion of hourly observations made at Sibsagar and Goalpara.* Fol. Calc., 1892. 60 pp. 12 pl.

K. NEDERL. METEOROLOGISCH INSTITUUT. *Nederlandsch Meteorologisch Jaarboek voor* 1880. 32. Jaargang, ii. Deel. Obl. 4to. Utrecht, 1892. 295 pp. (This is the last of the series of parts ii. of the Jaarboek.)

K. NEDERL. METEOROLOGISCH INSTITUUT. *Nederlandsch Meteorologisch Jaarboek voor* 1891. Obl. 4to. Utrecht, 1892. 354, xxxvii. pp.

KAMMERMANN, A. *Résumé météorologique de l'année* 1891 *pour Genève et le Grand Saint-Bernard.* 8vo. Genève, 1892. 146 pp.

KLEIN, H. J. *Jahrbuch der Astronomie und Geophysik. Enthaltend die wichtigsten Fortschritte auf den Gebieten der Astrophysik, Meteorologie und physikalischen Erdkunde.* ii. Jahrgang, 1891. 8vo. Leipz., 1892. 400 pp. 6 pl.

KRAKOW. *Royal Society of Science. (Materials for Galician climatology, collected by the meteorological section of the Physiographical Commission, for the year* 1891.) (Text Polish.) 8vo. Krakow, 1892. 246 pp.

LISBOA. *Annaes do Observatorio do Infante D. Luiz.* 34. anno, 1888, vol. xxvi. Fol. Lisboa, 1892. 142 pp. (Meteorologic and magnetic observations.)

LISBOA. *Annaes do Observatorio do Infante D. Luiz. Observacoes dos postos meteorologicos,* 1886. Fol. Lisboa, 1891. 134 pp.

LYON. *Météorologie Lyonnaise par* M. CHARLES ANDRÉ. *Annles météorologiques,* 1887–8–1889–90. 4to. Lyon, 1889–91.

MCADIE, ALEXANDER. *Abstract of a report on some experiments on atmospheric electricity.* (From the Annals Astr. Obs. of Harvard College, vol. xl. pt. i. append. (A. pp. 53-58.)

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION. *Climatology of North Carolina (from records of* 1820 *to* 1892,) *including the fifth annual report of the N. C. State Weather Service.* 8vo. Raleigh, 1892. 184 pp.

NOYES, ISAAC. P. *Meteorology. The weather map and the "Rainmakers."* 8vo. Wash., 1892. 46 pp.

NORTH CAROLINA STATE WEATHER SERVICE. *A general sketch of the climate of North Carolina. An extract from the "Climatology of North Carolina," issued as the fifth annual report for* 1891, *of the North Carolina State Weather Service.* 8vo. Raleigh, N. C., 1892. 24 pp.

ODESSA. *Revue météorologique. Travaux du réseau météorologique du sud-ouest de la Russie l'année* 1891. Vol. ii. par A. KLOSSOVSKY. (Russian Text.) Fol. Odessa, 1892. 90 pp. 7 pl.

OHIO METEOROLOGICAL BUREAU. *Ninth annual report for the year beginning January 1, and ending Dec. 31,* 1891. 8vo. Columbus, Ohio, 1892. 156 pp. 4 ch.

REMONDINO, P. C. *The Mediterranean shores of America. Southern California: its climate, physical and meteorological conditions.* 8vo. Phila. and Lond., 1892. 160 pp. 3. pl.

TROMELIN, LE GOARANT DE. *Lois mécaniques de la circulation de l'atmosphère. Surfaces isodenses, grains, circulations générales et secondaires.* (Extr. de la Revue Scientifique.) 8vo. Par., 1892. 22 pp.

WHITEHEAD, MORTIMER. *The Weather Bureau of the United States Department of Agriculture. Its organization, history and vast importance to all farmers.* (From "The American Farmer," April 1, 1892.) 8vo. Wash., 1892. 14 pp.

CLAYTON, H. H. AND FERGUSSON, S. P. *Measurements of cloud heights and velocities.* In Annals Astron. Obs. Harvard College, vol. xxx. pt. iii. 4to. Camb., 1892. pp. 205–268. 1 pl.

---

## PUBLICATIONS RECEIVED.

"Bolletino Mensuale pubblicato per Cura dell' Osservatorio Centrale del Real Collegio Carlo Alberto in Moncalieri." Series ii., Vol. xii., Num. ix-x.

"Memorias y Revista de la Sociedad Cientifica 'Antonio Alzate,' publicado bajo la Dirección de Rafael Aguilar y Santillán," Mexico. Tomo vi. (1892-93). Números 1 y 2. 8vo, pp. 80.

"Ciel et Terre," Bruxelles, No. 15. 1 Octobre, 1892.

"Uebersicht der Witterungsverhältnisse im Königreich Bayern während des August, 1892." The unusually high temperatures of August are explained as the result of an extended and long enduring high pressure over northern Europe.

"Beobachtungen der Meteorologischen Stationen im Königreich Bayern," herausgegeben von der K. Meteorologischen Centralanstalt, durch Dr. Carl Lang und Dr. Fritz Erk. München, Vol. xiv., No. 2, 1892. 4to, pp. 56.

"Das Wetter," Braunschweig, October, 1892.

"The Scottish Geographical Magazine," Edinburgh. Vol. viii., No. 11, November, 1892.

"Astronomy and Astro-Physics," Northfield, Minn., November, 1892.

"American Journal of Science," New Haven, Conn. Vol. xliv., No. 263, November, 1892.

"Proceedings and Addresses at a Sanitary Convention held at Holland, Michigan, March 3 and 4, 1892." Supplement to the Report of the Michigan State Board of Health for the year 1892. Lansing. 8vo., pp. 66.

"Monthly Bulletin of the California Weather Service, in Co-operation with the State Agricultural Society," compiled by James A. Barwick,

Director, State Weather Service. Sacramento, Vol. ii., No. 3, September, 1892.

"Monthly Review of the Colorado Weather Service, for October, 1892." Denver, J. J. Gilligan, Observer, Weather Bureau, Director.

"Louisiana Weather Journal." New Orleans, G. E. Hunt, Director, Louisiana State Weather Service, editor. Vol. v., No. 11, October 15, 1892.

"Report of the North Dakota Weather Service for the month of August, 1892." Bismarck, W. H. Fallon, Observer, Weather Bureau, Director.

"Bulletin of the New England Weather Service for the months of September and October, 1892." Boston, Mass., J. Warren Smith, Observer, Weather Bureau, Director.

"Tennessee Journal of Meteorology," Nashville. Vol. 1, Nos. 11 and 12, October and November, 1892. 8vo., pp. 12.

"Monthly Bulletin of the Texas Weather Service, issued in Coöperation with the Galveston Cotton Exchange," Galveston. Vol. 5, No. 2, August, 1892.

"Wisconsin Weather and Crop Journal," Milwaukee, October and November, 1892.